THE QUARTERLY

JOURNAL OF SCIENCE.

APRIL, 1865.

ORIGINAL ARTICLES.

SCIENCE, POLITICS, AND RELIGION.

As a rule, the scientific world is too much engrossed with its legitimate occupations to bestow aught but a passing notice upon the expressions of feeling in regard to its action and influence, which emanate from those who are not directly interested in scientific pursuits, and it is only what may be termed its civil agitations that command its attention. Secure in the sense of its growing influence and irresistible progress, Science can afford to smile at the little squibs that are from time to time thrown on its path, and may safely permit its truths to be ridiculed or perverted by persons who conceive that such a course will conduce to their political popularity, or will enable them more readily to attain religious ascendancy.

But it is useful that scientific men should occasionally look up from their labours and cast a thoughtful glance around, not alone with a view to ascertain what the world thinks of their efforts, but also that they may be able to form an accurate estimate of the practical fruits of their occupations, correct the errors of the past, and resume their work with the additional experience that must inevitably result from such a survey. Keeping these objects in view, then, we feel ourselves justified in taking some notice of three or four circumstances that happened during the last quarter of the year 1864, all of which caused no little sensation at the time of their occurrence.

The first was the attempt, on the part of "some person or persons unknown" (excepting in name), to extract from the scientific world a profession of religious faith, a proceeding innocent enough in itself, but which, if it had not been arrested in time, would doubtless have inaugurated a period of coercion that must have militated against the progress of scientific inquiry. A few sincere and well-meaning scientific men signed the "declaration," which censured the attempt to bring Science and Scripture into antagonism, and which, as our readers are doubtless aware, was intended to be published as soon as a

sufficient number of signatures should have been obtained. The attitude, however, which was assumed by Sir John Herschel and others of high repute, nipped the project in the bud, and effectively suppressed the attempt that was being made by the originators of the movement to interfere with freedom of thought and to convey to the outer world a very false impression of the character and intentions of scientific men.

"*Qui s'excuse s'accuse*" is a proverb remarkably applicable to the present case. Let us suppose the compilers of the document to have been perfectly honest in their object and in their desire to obtain signatures, and that the scientific men of Great Britain had signed it with equal sincerity, what would the world have said when the bull was promulgated?

"Here is the *élite* of Science indulging in a protest against its own irreligion! What must *we* think of them if they have formed such a lowly estimate of themselves?"

Not desiring to be uncharitable, we will not meddle with the assumption that the originators of the document were sincere, but we venture to affirm that of the whole number of signatures that *might* have been appended had the movement progressed, about one-third would have been those of persons who honestly believed that their protest would be of service to Science as well as to Religion; an equal proportion would have signed in order that their names might not be omitted from the long list of F.R.S.'s and LL.D.'s which enriched the sheet, and the remaining third, lest their refusal should mark them as infidels.

There can be no doubt that from time to time works do appear, the publication of which should be condemned, but the antidote to these is the pen of the critic, honestly and fearlessly applied to meet each particular case, and not a general "confession of faith." Whilst a rightful censure upon irreligious works has never failed to bring them into disrepute, the issue of a document such as the one referred to above, would have had the effect of rendering such treatises popular, inasmuch as the attempt to interfere with free thought and unfettered inquiry would merely have served as a plea for their publication. The end aimed at would therefore not have been attained and, as Sir John Herschel very properly said at the time, the document would simply have proved a fresh element of discord in the "already too discordant relations of the Christian world."

The second event to which we would refer, was the attempt of the Right Hon. Benjamin Disraeli to cast ridicule upon those naturalists who have adopted the views of Mr. Darwin with respect to the origin of species. This escapade on the part of the leader of Her Majesty's Opposition was sufficiently ridiculous to afford a legitimate theme for the pages of 'Punch,' where the pencil of Mr. Tenniel exhibited it in its true light and with telling effect. But Mr. Disraeli's attack upon scientific investigators was something more than ridiculous; it was what he certainly did not intend it to be—very unbusiness-like and impolitic. Surely his conception of the scientific men of the present day must have been formed from those records of mediæval times, the

perusal of which has no doubt, in other respects, proved very beneficial to him in his literary career. But he should know that our *savans* no longer seclude themselves as formerly in the turrets of deserted castles, there to pursue their vocation by the flickering lamp of midnight, and exercising no further influence on society than the terror which their mysterious operations inspired in the surrounding peasantry. As a rule, their habits of observation enable them to reason with more accuracy than other men, and to arrive at more correct conclusions on those subjects to which their attention is earnestly directed. They will be apt to compare Mr. Disraeli's address with that delivered shortly afterwards by our aged Premier, when he treated of the progress of agriculture and the application of steam to tillage, and they will have no difficulty in perceiving in the one an abuse of intelligence and a bid for office at the expense of progress; and in the other, a laudable effort, during the tenure of power, to keep pace with the progressive spirit of the age. If Mr. Disraeli had shown some better cause for "going with the angels" than the desire to catch a few additional votes, by currying favour with extreme churchmen at the expense of charity and progress, he would have been listened to with respect; but as the matter now stands, it would appear that political instinct, rather than reflecting reason, was the motive force, and this new manifestation of "vis *conservatrix* naturæ" will afford, if anything, a fresh piece of evidence to Mr. Darwin and his school of the truth of the doctrine of natural selection! Mr. Disraeli's sneer at the attempts of our modern naturalists (many of whom, by the way, are ministers of the Established Church) to account scientifically for the differences of species, will be remembered by them at some future time; and if, as on a former occasion, he should propose to confer a special franchise upon them for their intelligence, his extra-parliamentary utterances on this occasion may serve them as a standard whereby to measure the sincerity of his professions and the value of the proffered boon.

We shall have occasion hereafter to refer more fully to the question treated with such levity by Mr. Disraeli, and will now pass on to the last occurrence, which we cannot say affected Science, but bore some relation to its progress: that was the promulgation of the Pope's Encyclical Letter, and its eighty modern errors.

Whilst the cry is everywhere "Educate, educate, educate!"—the miner, that his life may be less endangered; the agriculturist, that he may know better how to wrestle with natural difficulties, and employ more rationally the blessings of Providence; the merchant, that he may be something beyond a mere bartering creature; or the soldier, that he may be more intelligent than his rifle—the infallible head of that sect of Christians which claims to be the universal Church, decrees that the "knowledge of philosophical things," and that all "popular schools," must submit to ecclesiastical authority; that they must, in fact, be controlled by priests, who, little educated excepting in the mysteries of their faith, have assumed, and continue to assume the authority of the Almighty whilst they seek to fetter and restrict the action of that intelligence to which He has given almost unlimited freedom. And yet we really have no great fault to find with the eighty "errors," for

the only one that strictly relates to Science, No. 12, is literally correct. Who will deny it to be an "error" that "the decrees of the Apostolic See, and of the Roman congregations, fetter the free progress of Science?" Whatever they may have been two hundred years since, such "decrees" are innocent enough at present; and what is more, Catholics themselves who care about Science at all, are really more liberal in their views than many who profess to belong to a more tolerant faith. But whilst a few designing persons, or those sincere but unreflecting men who constitute the extremes of religious and political denominations, may applaud attacks upon Science, or sanction the attempt to cast stumbling-blocks in her way, the more moderate members of every section of the community, Protestants and Catholics, Liberals and Conservatives, all, indeed, whose support and approbation are likely to benefit scientific movements, will not fail to deprecate such an attitude on the part of the uninformed, and to share with scientific men their contempt of these unmeaning explosions of noisy ignorance. It is almost needless to say that the real tendencies of the age are towards unfettered thought, free inquiry, and an open opposition to priestly or clerical interference in scientific or secular affairs.

But it is not enough that we should point the finger of scorn at those who deride the exertions of scientific men, or that we should protest against the injustice of their assailants; it behoves us to inquire whether these attacks and sneers are justified by any apathy or indiscretion on the part of scientific investigators and professors. Are they performing their part in the great work of civilization? Do scientific tenets deserve to be branded as atheistical? (for that is the concealed inference intended to be conveyed by most of those who protest against modern theories). Are inquiries into the operations of natural forces calculated to elevate or to degrade the human mind? These are the interrogatories which scientific men should put to themselves, and they are the topics we now propose briefly to consider.

In regard to the first inquiry, it will be found that here, as in every other human pursuit, the fields before us are so immense, when compared with the plot over which we have passed, that the zealous practical philosopher cannot help feeling how slow is his progress and how great are his shortcomings. Of this truth we will adduce one or two illustrations.

It is but as yesterday that the streets of our great cities were illuminated at night by dismal oil lamps, few and far between, whose feeble light served the ends of the footpad, but afforded little aid to passengers or to the guardians of the night. Now there is gas and petroleum, and we shall probably be told that the world will shortly be favoured with the magnesium and electric lights for all purposes of illumination, and that we shall then have no more cause to dread the darkest night than the broad light of day. It is impossible to deny that, *theoretically*, great strides have been made in the art or science of illumination, and we should be deeply grateful to the students of physical science for the additional light that has been afforded to us, more especially for the promised improvement in the character of those

coast beacons that direct the wayfarer at sea. But if our cities and towns are now somewhat safer at night than they were before the introduction of gas (and there are many persons who but recently, during the garotters' reign, pronounced them less secure than formerly), is it to Science that the increased safety is due? Has she, in this respect, assumed her true position amongst our modern civilizers? We apprehend not; for when we consider that, by the employment of the physical and chemical forces, the blackest darkness could be dispelled, and our streets and suburbs illuminated with a clear and steady light but slightly inferior to that of the great "orb of day," exposing all the vice and crime and libertinage which are perpetrated under cover of the night, then, indeed, we feel that scientific men have still a glorious mission to fulfil, to render their discoveries available for social ends, increasing not the comforts only, but the safety of the human race.

Excepting that it has been employed in a small number of our coast lighthouses, and by a few of our leading investigators to aid them in their physical or chemical researches, magneto-electrical illumination (and still more the magnesium light) is little else than a curiosity which serves here and there to amuse and perhaps in some cases to instruct, limited scientific audiences.

It is beyond a doubt that Science will complete the work she has begun, and will render practically useful what is now theoretically valuable; and judging from some inquiries that were made of us in regard to the possibility of lighting up ironworks and factories (in both of which the requisite steam-power is easily obtainable) by magneto-electricity, shortly after the appearance of the article on this subject in our first Number,* we feel confident that the time is near at hand when the practical benefits accruing from the researches and experiments of scientific investigators will become manifest.

In the prosecution of such a work as this, chemists and physicists have no cause to apprehend either priestly interference or political sneers, and we would direct their attention to the motto that distinguishes this Periodical, as a watchword to guide them in their duty. To them it is especially appropriate. They have the power to dissipate our physical and moral gloom; to raise a vivid light above our cities; in our workshops; to penetrate our mines and tunnels with an artificial day! And so they may assist in the suppression of our vices and our crimes; may lighten toil, and render life secure. Are not these objects worthy of the exercise of man's best faculties? Can priest or politician teach us a more sacred duty? †

But if the magneto-electric mode of illumination is not becoming developed as rapidly as some might desire, the progress made in the employment of another form of electricity for purposes of intercommunication is most satisfactory, and exhibits at once the indomitable energy of our race, and its love of gain and conquest. Impelled by commercial

* Dr. Gladstone on "Lighthouse Illumination by Magneto-electricity." 'Quarterly Journal of Science,' vol. i. p. 70.

† Since this article was written, an account of a miner's electric lamp has been forwarded to us: it will be found in our Chronicle of Mining.

enterprise rather than by philanthropic considerations, the baffled and defeated electrician has once more allied himself with the wealthy and enterprising trader; and with replenished exchequer, they have set to work anew to bind the Eastern with the Western hemisphere. Guided by the practical experience of the past, and by the researches of the closet-investigator, they set out upon each trial with fresh precautions and improved materials, and so not only is the end brought nearer and nearer, but the collateral study and observation necessary for its attainment add a fresh fund of information to our mental treasury, and open out new fields for the practical application of the science investigated.

It will be a matter of deep interest to know whether the unfortunate and much-abused 'Great Eastern,' that triumph of modern engineering skill, will faithfully perform her task of depositing the cable upon the construction of which so much care has been bestowed; and the enterprising men who are engaged upon this second effort to link more closely the two great families of English people, may rest assured that their anxiety for the result will be shared by all scientific men and friends of progress.

Whilst we speak of the combination of commercial with scientific enterprise, we are once more reminded of our aged Premier's observations on the application of steam to tillage. If we remember rightly, Lord Palmerston threw out the suggestion that, as not every farmer can afford to purchase a steam-plough, capitalists should purchase and let them out on hire. No doubt he is aware that such a practice has long prevailed with regard to steam thrashing-machines, and that there are many persons who derive a handsome income from this source. But it has often been a matter of surprise to us, that during the recent mania for limited joint-stock companies, when they sprang up like mushrooms, some with avowed aims chimerical and laughable enough to have been fit subjects for a farce, had they not too often formed the basis of a very painful drama; that during this extravagant fever it should never have occurred to some honest speculator to establish a company for the purpose suggested by the Premier. Possibly such a project may have been set on foot, and have escaped our notice; but in all probability it was far too legitimate an enterprise for "bulls" and "bears."

Another combination of scientific and commercial enterprise to which the greatly abused Act might be applied with advantage is the utilization of sewage.

This subject has been much agitated of late, and its discussion belongs rather to the agriculturist than to the student of natural or physical science, but it may be satisfactory to the former to receive a word of encouragement to counteract the obstructions which ignorance and prejudice occasionally throw in his way. He certainly has the approval of the naturalist, who sees in his efforts to turn refuse matter to good account, a wise imitation of that Providence which knows no waste but which with the results of decay rejuvenates nature and clothes her in fresh beauty. But even these zealous operators are liable to adverse criticisms, and it is right that they should observe

and profit by the strictures to which they are subjected. A writer in a weekly contemporary remarked some time since that in passing over a field manured with "sewage," his nostrils were offended by the odour, and he expressed the hope that "the incense breathing morn" might not soon become a thing of the past. In our large towns, and more especially in those where industry has made the most rapid strides, this is already the case, and the pale-faced citizen is compelled from time to time to seek renewed health and strength in the open fields and country lanes. Certainly the sewage of those towns renders them at present still more unhealthy than they would otherwise be, and it sometimes taints the sources of our water supply, causing men to drink the poison as well as to inhale it. Still we should look with apprehension upon the pouring of this flood of noxious liquid over the fields that form a refuge from the overcrowded city, unless the most effective measures were taken to secure its complete deodorization. May greed of gain never do its evil work here as it has done in those districts where the injurious products of chemical manufactures have laid waste the country round, and where legislative enactments have been requisite to teach men their duty towards their neighbours. We recommend Mr. Disraeli to follow the example of his noble chief (who has been a great sufferer by the last-named evil), and to direct his attention to such objects as these. He would then succeed in gaining popularity amongst the class whose suffrages he more especially courts, "the agricultural interest," and would earn the respect even of the despised Darwinians, who would give him credit for seeking to alleviate the pains and penalties that accompany the "struggle for existence!"

Having thus briefly touched upon a few important scientific movements of a utilitarian character, in order to exhibit the necessity for increased vigilance and activity on the part of scientific men, we would now inquire whether their theoretical observations are deserving of the derision and denunciation which they have elicited in certain quarters; and we shall first direct our attention to the Darwinian doctrine of transmutation of species by "natural selection."

When Mr. Darwin published his book he told us that a close observation of nature led him to believe that new species of plants and animals were formed from previously existing ones by the "natural selection" of types, adapted to the changing character of the inorganic world, or, in other words, through the power which certain individuals possessed, by virtue of their peculiar structure, to cope with natural difficulties under which their congeners succumbed. Those privileged individuals bred and multiplied until surrounding circumstances (inorganic nature) necessitated a further modification in them, and then a fresh "natural selection" took place; or, to speak more correctly, a slow change was from these causes always proceeding in animal and plant types concurrently with the changing surface of the globe. The author adduced a large amount of precise and minute evidence in the form of changes *artificially* effected by himself and others in domesticated animals, very similar to those which, on a large scale, he regarded it to be the prerogative of nature to produce.

We may observe in passing, that this power on the part of man to bring about changes in species such as those referred to by Mr. Darwin constitutes, as it appears to us, an irrefragable proof that the larger changes produced in nature were executed by and under the direction of a wise and mighty Being, who adapted fresh forms to new conditions of existence.

And so it must have appeared to the modest and reverential author of the work, for he told his readers that the slow and unerring change which occurred in the various species of living beings adapting them to the altered condition of the globe, not only appeared to him to be a more rational and scientific view of the case than the modern interpretations of the traditional account, but that it conveyed to him a nobler conception of the Majesty of that Being who from a few simple typical forms had, in the course of long ages, evolved the beautiful and varied Creation of the present day. Mr. Darwin has never, that we are aware, advanced his hypothesis as an undoubted truth, but as an unproved theory, and has invited young and rising naturalists to test its accuracy, promising to furnish the scientific world with a large amount of additional evidence at a future time. With some unimportant exceptions this promise has not been fulfilled, owing, we regret to say, to the ill-health of the author.

Those persons who have read Mr. Darwin's book unbiassed by theological prejudice on the one hand and by scientific dogmatism on the other (for not all his followers have been so cautious and temperate as he, and there is such a thing as scientific as well as political or religious terrorism), and who have carefully considered the published opinions of other eminent observers in Zoology, Botany, and Palæontology, cannot fail to be convinced that his researches and generalizations have brought us at least one step nearer to a clear comprehension of the laws of animal and plant life, besides giving such a stimulus to natural history studies as no preceding age has witnessed. Neither can our readers fail to observe that those slow and gradual changes which Mr. Darwin attributes to the animal and vegetable kingdom, are in perfect accordance with a similar theory formerly contested with great bitterness, but now universally accepted, in regard to the Geological formations; and that the growing conviction with respect to the great antiquity of man also points in the same direction. Beyond this we feel that we have no right to go; but others think differently.

For some time after the publication of his work, Mr. Darwin's theory gained ground very rapidly, and although a little reaction has set in in certain quarters, there is at present a considerable number of scientific men of undoubted sincerity and accuracy, who are implicit believers in its correctness, regarding it as the only scientific mode of solving the problem of "species," and who, without hesitation, refer to it all past and existing biological phenomena. Now it appears to us that until a scientific theory of this nature is almost universally accepted (and not even its most zealous champions will advance such a claim for the doctrine of "natural selection"), it should be the aim of its advocates to pour into the scale every particle

of evidence they can find in its favour; but that evidence should consist either of old and acknowledged facts, or of new discoveries. Some writers and observers do not, however, see the matter in this light, and instead of testing the accuracy of the doctrine by their discoveries or inquiring whether these afford new evidence in its favour, they at once employ it as an acknowledged standard whereby to estimate the value of their new researches, assuming their favourite theory to be the complete law of life, and with the aid of their new facts, drawing inferences in regard to the past and present condition of the globe and of its inhabitants, which would no doubt be perfectly correct, provided Mr. Darwin's theory be the whole truth. Fallacious as this method of induction may be, it is in our judgment infinitely preferable to another mode of reasoning, which discredits without inquiry all new data advanced by the believers in "natural selection," on the ground that the primary doctrine is impious, or what not; or which rejects as unsound all inferences that may be in harmony with the detested creed!

Notwithstanding the kind of "circle sailing" adopted by the first class of reasoners, we are always sure, if we accompany them, to learn something new on the voyage, and although their statements may be far from convincing, they are certain to afford us a fresh opportunity to form a correct opinion on the subject. It is not difficult to distinguish between legitimate inferences drawn from facts, and others which may be the result of feeling; and as regards the followers of Mr. Darwin, we have sufficient faith in their sincerity to believe that they would wish every communication to be carefully considered, not examined from their point of view or implicitly received like the Pope's 'Encyclical,' but that their facts and inferences should be weighed, and sifted, and criticized, and only accepted when they approve themselves to the good sense of the scientific community.

As to the accusation of materialism, another expression for atheism, to which some of the followers of Mr. Darwin have rendered themselves obnoxious (for those who profess to find any atheism in his work are not entitled to credit for candour and sincerity), it is to be deeply regretted, not only on their own account, but for the sake of Science and free inquiry. It is just as absurd in those would-be philosophers to imagine because there are accumulating indications that the processes of nature were in past ages all brought about, more or less, by secondary agencies, that therefore there is not a Creative power nor a watchful Ruler whose existence was needed to bring the universe into existence and maintain the fabric in order and harmony, as it would be for a few sapient bees to believe that because they find themselves in a comfortable hive with a convenient exit, and because flowers spring up and blossom periodically in their vicinity, therefore there is no gardener nor bee-master, and no being higher than their apiarian majesties! We shall not gratify the love of notoriety, which usually impels such persons to publish their unreasoning dogmas, by mentioning their names, but shall dismiss them by placing them in the same category with their opposites, who can see no religion in nature because it does not accord with *their* sectarianism.

When we reflect for a moment upon the profoundly religious lessons conveyed to man's mind by a contemplation of nature in its modern aspects, we are astonished to find that there should be men assuming to be the leaders of public opinion in any civilized country, who do not perceive that the modern Temple of Science is, or should be, as divine an institution (for it is founded by the All-wise himself) as the most sacred temple that ever was raised by the hand of man in ancient or modern times. We can only account for such blindness on the assumption that these persons must have constantly burrowed in their own limited plots, and that their eyes having been thus rendered unnecessary, a kind nature has atrophied the organs, and so rendered their possessors less liable to the danger or inconvenience which might arise from any sudden influx of light.

For what purpose has man been taught the use of the telescope, if he is to regard the worlds around with unreasoning amazement? or why has he been entrusted with microscopic vision, if there are no lessons of wisdom to be learned in the invisible world? Wherefore that restless curiosity which prompts him to continue his inquiries as to his own nature and his relations with the lower animals even though the result of his investigations be repulsive to his human feelings, if not to teach him that if he would be eternally happy he must rely upon something beyond his flesh, or the material possessions secured for him by his natural superiority.

The student of nature may prosecute his observations in whatever sphere he pleases, in the fullest confidence that his employment is a sacred one. Whilst the priestly charlatan perpetuates false mysteries, appealing to bleeding saints and sweating statues, in order to check the diffusion of useful knowledge that he may with greater impunity assume the authority of the Almighty, the student of Science seeks to solve real mysteries that he may add to the store of human knowledge; he endeavours to comprehend and disinterestedly expound the laws of nature, and wield its forces for the present and future welfare of man. The reverent study of Science does not, and probably never will, initiate man into all the secrets of the Almighty, for they appear far too high for human comprehension; but it assists him in maintaining his religious conceptions on a level with his advancing knowledge in other respects, and prevents him from falling a victim to that self-sufficiency which results from any kind of success.

For, how expansive and ennobling are the thoughts inspired into the human soul, when, through the outer sense, it contemplates the universe as it appears to-day! What fresh and happy feelings such an occupation generates, and what a peaceful and contented frame of mind it leaves! And why? Because it, for the time, enables the spectator to forget *his* works and ways, in contemplating those of the Almighty; excluding from his mind all thoughts of worldly care; all the anxieties of mortal life and mortal strife.

It is indeed difficult to convey to those who have not experienced them, an adequate idea of such emotions: no creed, no formula could present them to the mind. Let the reader go forth on some clear

starlit night, and with the telescope inspect that ruddy planet which has shone so brightly in the heavens of late. With adequate enlarging and defining powers he may discern its continents, and seas, and polar snows so patent to the practised astronomical observer; and it will be no great stretch of the imagination to ponder on the nature of its denizens, for doubtless it is peopled like our own bright world.

Remembering who rules in yonder distant orb (itself a pigmy amongst giants in our solar system), he may now change the scene, and scrutinize a water-drop beneath the microscope. There he will see a multitude of forms, completely hidden from the unaided sight; some almost shapeless, others of the simplest type. And if he patiently observe this scene, he will perceive these Protozoa, these lowest forms of life, to be endowed with locomotive powers, and instincts suited to their habitat; may see them grow and multiply, and, just as in his outer world, vanquish or yield in one incessant "struggle for existence." Here, then, he finds the same presiding Power as in the distant planet, and if his little mind be capable of grasping such a thought, let him reflect that the same Being rules alike in *every* floating orb and *every* water-drop!

But we shall be told that the contemplation of these evidences of mighty power does not appeal to the emotions of the human heart, however it may serve to educate the intellect.

We would not for a moment claim for nature an all-sufficing influence for good; but even in this respect it is far from being impotent; and if there be those who can find in it no moral influence, the blame rests with them and not with nature. What a contrast is presented to us when we compare the character of man as revealed by modern society, with the Divine nature as it is read by the light of modern science!

If Man ascends from what he deems a lowly station to a higher sphere in life, the early objects of his thought and care are soon forgotten or neglected in the turmoil of the larger world in which he moves. For him the humble friends of youth or early manhood pass into another world long ere they are removed from this. Important duties press; he has no time to think of trifles nor of little men, except when these applaud *his* acts or further his great ends. He does not heed the importunity of those who wish to benefit by his promotion, not even though they were the means of raising him to his exalted station. But is it so with Him whose laws the man of science seeks to fathom and diffuse abroad? Whose power has brought the world into existence; whose forces guide the planets in their course; who slowly but unerringly works out the beautiful design; who raises up, first sentient creatures, then reflecting beings like Himself, and, watching o'er the fate of each, selects the strong and good, confers on them dominion over those who break His laws, and ministers to the happiness of all!

The Omnipotent, whose thoughts are occupied with His vast scheme, so little understood by man, cares equally for worlds illumined by His glorious suns, and for the animalcules which disport themselves so joyously within the artificial sunshine reflected from the

mirrors of our microscopes! He lacks not the applause of any; has therefore no necessity to slight the little and court favour with the great. Nor is He limited by time and space; constrained to turn His thoughts this way to-day or that to-morrow; to supervise at day-break here, at sunset yonder. We know full well that whilst He rules in Mars or on our globe, and penetrates our inmost thoughts He also sees the lowliest of His creatures, and numbers not alone the days of Man on earth, but also the few fleeting moments of the animalcule's transient existence. No object is too great, nor any too minute to elude His observation; and all created works present the impress of almighty will, omniscient wisdom, and unbounded goodness!

These are amongst the social, moral, and religious lessons taught by Modern Science, which knows no sect and recognizes no political distinctions, but whose right-minded followers seek to elevate their fellow-men without regard to creed or station and to confer the largest sum of happiness on all mankind.

ON THE APPLICATION OF SPECTRUM-ANALYSIS TO MICROSCOPICAL INVESTIGATIONS,

AND ESPECIALLY TO THE DETECTION OF BLOOD-STAINS.

By H. C. Sorby, F.R.S., &c.

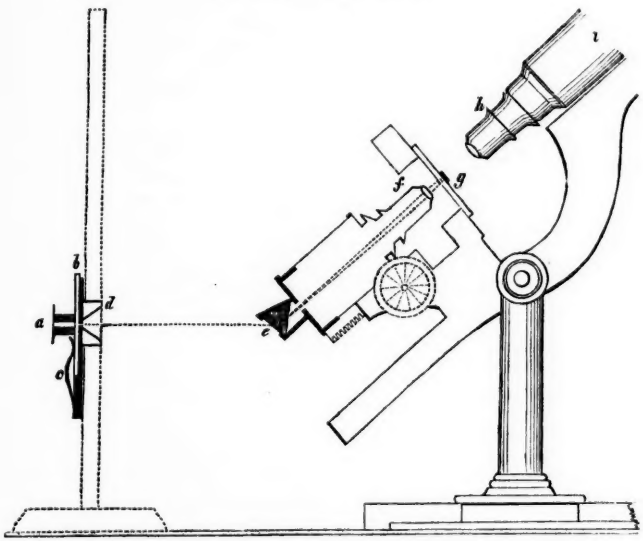
1. Introduction.—2. Description of the Instrument.—3. Spectra of Crystalline Salts, and of their Solutions.—4. Determination of the relative amount of per- and prot-oxide of Iron in Minerals.—5. Application of Polarized Light with the Spectrum.—6. Detection of Blood-Stains.—7. Conclusion.

1. *Introduction.*

Since various substances may appear to have the same colour, and yet act very differently on the spectrum, or, on the contrary, may give the same characteristic spectrum, and yet differ materially in colour, it is in all cases desirable to study them by means of the prism. As is well known, this method has been employed with remarkable success in various branches of science; but, so far as I am aware, has not hitherto been applied to microscopical inquiries. In order to accomplish this, I made a number of experiments, and at length contrived an arrangement which, so far, has answered every purpose required of it. I have also discussed the various particulars with my friends the Messrs. Beck, who intend to adapt a similar arrangement to their microscopes, and we cannot perceive how any considerable alteration could be made with advantage, except such as would be required in the case of microscopes of different construction. I shall therefore describe what I have adapted to my own, one of their large binocular instruments.

The general construction will be more readily understood by reference to the accompanying Figure 1 :—

FIG. 1.—*Spectrum Microscope.*



The only addition to the microscope itself is the prism (*e*) and its mounting, shown by the dark lines. This fits into the bottom of the movable tube carrying the achromatic condenser (*f*). Detached from the microscope is a long narrow slit, shown in section at (*b c*); and the light passing through this at (*a*) is separated by the prism (*e*), and passes on to (*g*), where the image of the slit is seen as a coloured spectrum, on looking through the microscope in the usual manner. By this arrangement we can determine the character of the light transmitted by an object placed on the stage at (*g*), or by one held in front of the slit at (*a*); and, by a little adjustment, we can compare the two spectra side by side.

2. *Description of the Instrument.*

Having thus given a general account by way of introduction, I will now describe the apparatus in detail.

The slit is made of two brass plates about six inches long and one inch broad. The lower has two strips of brass fastened at each end, between which the other plate fits, so that it may be moved up and down, and fastened by means of screws, which clamp together the upper part of the strips. The edges of the plates, thus brought toge-

ther, are made quite straight and bevelled, so that by putting a small piece of thin writing paper at each end, pressing down the upper plate, and fixing it with the screws, an opening is left between the plates five inches long and about $\frac{1}{400}$th of an inch wide. The lower plate carries a small arm, fitting into a tube attached to a stand (shown by the dotted lines), such as is employed to hold a bull's-eye condenser, so that the slit is always horizontal, and that we may vary its height from the bottom of the stand, and the inclination of the face of the plates. Then, since it is often requisite to hold different sorts of objects in front of the slit, a piece of brass, to act as a stop, carrying a spring, is fixed on one side, as shown at (*c*), so that a square piece of glass can be held in the same position, or moved up and down directly in front of the slit. In the figure the plates of brass are shown by the black portion (*b c*), the glass by the unshaded part on the left side below (*b*), whilst the shaded part at *a* represents a small narrow tube into which any liquid may be put for examination. Large crystals or other objects, mounted on plates of glass, may also be held in the same manner. In some cases it is desirable to examine solutions held in test-tubes. For this purpose two pieces of wood are fixed on the other side of the brass plates, shown in section at (*d*), extending the whole length, and even projecting beyond them at each end. They are made in the V form shown in the figure, so that, whether the tube be small or larger, its centre may be directly in front of the slit; and wood is better than brass when it is desirable to examine hot solutions. Towards each end is a spring, so that two tubes may be held, and the spectra of the liquids they contain compared. Of course all parts of these fittings must be a good, dead black. I have covered the brass with black silk, which cannot be scratched by the glasses, fastening it down with liquid Indian rubber.

Since it is often desirable to have a very narrow spectrum, a prism of crown-glass is better than one of flint-glass; and, when a broader spectrum is required, it can be readily obtained by using a condenser of longer, or an object-glass of shorter, focal length. The prism should be fixed in the position shown at *e*, so that the light may enter at *a e*, and pass off at *e g*, at about equal angles. With crown-glass the front face (*e*) should therefore be inclined at about 10° to the axis of the microscope. The prism might be fitted just within the tube of the condenser; but I have fixed it as shown, so that a large Nicol's prism may be inserted above it, to be used as described in the sequel. For some purposes day-light must be used, especially when it is desirable to have the blue end of the spectrum well seen; but very often lamp-light is better, for Fraunhofer's lines do not interfere with the observations, the quality of the light is more uniform, and, the lamp being placed at about the same height as the prism, the requisite inclination of the microscope is then just that which is most convenient for the observer. In using a lamp, a large bull's-eye condenser should be placed between it and the slit, so as to give a broad or narrower image, according to circumstances; and by throwing the image of the edge of the flame on the object, a larger amount of blue

light may be obtained, if that be requisite. With day-light the condenser is not necessary, but the slit must usually be raised, the microscope inclined at a less angle, and a screen of blackened cardboard, with a suitable opening, placed in front of the slit, extending from the table to some distance above *b*, so as to shut out extraneous light. Since the uniform blackness of the field is often impaired by seeing the reflection of various parts of the microscope from the upper surface of the condenser, it is in all cases desirable to have a blackened tube fixed over the end of the object-glass, extending down nearly to the focus.

When all is properly arranged, the narrow beam of light passing through the slit at *a*, gives a spectrum at the focus of the achromatic condenser (*f*), which is so adjusted that the focus may coincide with any object placed on the stage at *g*. Both are magnified by the object-glass (*h*), and seen on looking down the microscope; the spectrum extending horizontally across the field, having the red at the top and the blue and violet at the bottom. In my description it will therefore often be convenient to speak of the red as the upper, and the blue as the lower, end of the spectrum. The breadth depends on the focal length of the condenser and object-glass, and also on the distance of the slit from the prism, and the thickness and refracting power of any object placed on the stage at *g*. By using suitable lenses, we may readily obtain a spectrum $\frac{1}{1000}$th of an inch in width, so that the whole may be seen through a crystal of that minute size, or we may make the spectrum spread over the whole field of the microscope. However, it is usually much better not to have the condenser and object-glass of short focal length, since there is then more light, the spectrum is of better quality, and the different portions in better focus. A condenser of $\frac{3}{8}$rds of an inch focal length combined with an object-glass of $1\frac{1}{2}$, or a $1\frac{1}{2}$ combined with a $2\frac{1}{2}$, answer very well.

By using a micrometer in the eyepiece, the position of any dark or bright band in the spectrum can be readily measured with sufficient accuracy. I find it very convenient to use such powers, and fix the slit at such a distance that the whole spectrum measures 12 divisions of a micrometer, having lines $\frac{1}{100}$th of an inch apart. In that case the sodium line is as nearly as need be 3 from the top and 9 from the bottom. The slit can be easily kept at the proper distance by means of a strip of wood resting above the prism and on the slit. To get a correct datum with lamp-light, I have a platinum wire with a loop holding common salt, so arranged that it can be turned into the flame, and the sodium line seen as a bright yellow band in the spectrum. After making one of the chief lines of the micrometer coincide with this, the wire can be turned out of the flame, and the position of any part of the spectrum measured. If day-light be employed, and a good object-glass used for the condenser, Fraunhofer's principal lines can be readily seen, and D may be made use of as a datum in a similar manner.

I trust I have now made the general arrangements sufficiently intelligible, and will proceed to describe some of the objects to which

the instrument may be applied. Of course, a number of these could be studied by means of an ordinary spectroscope; but then, not only are they in many cases so intimately connected with microscopical inquiries, that a microscope as such can be most usefully employed; but moreover, to say nothing about the advantage of making one instrument serve instead of two, with the very simple additions I have described, a spectrum microscope answers in some respects better than an ordinary spectroscope. In the construction of that instrument the aim is to have a wide spectrum, so as to distinctly separate well-marked lines, whereas the absorption bands seen in the spectra of many coloured bodies are often so faint, that they are quite invisible when spread out in a wide spectrum, though readily seen when narrow and more concentrated. This being the aim in constructing the spectrum microscope, it is necessarily inferior to an ordinary spectroscope when applied to the study of the lines in coloured flames, though, at the same time, it is by no means to be despised for rough experiments of that kind. The microscope should then be made horizontal, and the prism and slit vertical, so that the flame may pass straight in front for some distance.

3. *Spectra of Crystalline Salts and of their Solutions.*

The action of various coloured solutions and crystals has been already studied by many authors; but, so far as I am aware, not much attention has been directed to the relation existing between the light transmitted by solid or powdered crystals and by their solutions, in order to assist in arriving at a definite conclusion as to their condition when dissolved. This subject can be worked out in a very satisfactory manner by means of the instrument I have described; for the spectra of solutions and of very minute crystals can be compared side by side, and very slight differences easily detected. I have already collected a large amount of material, and, at first, intended to describe many of the facts in this paper, but I find that so many still remain to be determined, and the conclusions to which they lead are so intimately connected with a general theory of the connection between chemical and mechanical force, that they ought rather to form part of a memoir on that subject. I shall therefore now chiefly confine myself to a description of the requisite apparatus and the manner in which it may be used.

Highly-coloured solutions may be very conveniently kept in tubes about 3 inches long and $\frac{1}{4}$ to $\frac{3}{4}$ of an inch in diameter, made with one end flat and the other drawn out to a point, which can be sealed up after having introduced the solution by means of an air-pump. These are put lengthwise in front of the slit, as already described; and when all is properly arranged, the spectrum of the solution is seen extending over half the field of the microscope, divided from the natural spectrum by a narrow dark band, due to the flat end of the tube. I have also often mounted solutions in cells made from thick glass tube, similar to those used to mount objects in liquid, and have examined very faintly-coloured solutions in tubes varying in length up to 20

inches or more, closed at the ends with plate glass. These answer very well, and give a much longer spectrum than might be expected, on account of the light being reflected down the sides of the tube.

On placing a crystal on the stage of the microscope as at *g* in the figure, and the tube containing the solution in front of the slit as at *a*, it is easy so to arrange the focus of the condenser and the position of the tube and of the crystal, that the spectra of the salt and of the solution may be seen side by side, or with a narrow band of natural spectrum between them.

Since the width of the spectrum is modified by the thickness and refractive power of the substance placed between the condenser and object-glass, it is desirable to mount the crystal in Canada balsam, or else to fix a piece of glass of the same thickness alongside of it, otherwise the spectra seen through the crystal and outside it are not at the same focus or of the same width. It is also best to use a condenser and object-glass of as long focal lengths as circumstances will permit, raising, if it be necessary, the glass on which the crystal is mounted by means of a small stand fitting on the stage of the microscope.

Proceeding in this manner, I find that, as a general rule, crystalline salts have the same action on the spectrum as an equal amount dissolved in water; but there are many interesting exceptions due to special optical properties of the crystals, to the dissolved salt being probably combined with a different amount of water, or, in some cases, to isomeric changes. At all events, the facts throw much light on the state in which substances exist when dissolved.

4. *Determination of the relative amount of Per- and Prot- oxide of Iron in Minerals.*

When I first thought of applying a prism to the microscope, one of my chief objects was to employ it in studying the minerals seen in thin sections of rocks. So far, however, I have only been able to apply it to determine whether the iron exists as protoxide or peroxide, and, employing polarized light for the spectrum, to learn certain facts connected with the double refractive power of the minerals.

The action of persalts of iron depends partly on the amount of combined water. When anhydrous, the point of maximum transparency is situated about halfway between D and the extreme red, so that when the blue end of the spectrum is cut off to D, all the red is still transmitted. When hydrated, this maximum point is farther and farther from the red end, according to the amount of combined water. For example, in pentahydrated perchloride of iron, the maximum point is $\frac{2}{3}$ the distance from it towards D, whilst in the dodecahydrated it is situated near D, and the crystals are therefore yellow, but melt when heated into a solution of the orange-red pentahydrated. Very dilute solutions of the persalts absorb the blue end of the spectrum, and, on increasing the strength, they absorb more and more of the green. On the contrary, a strong solution of protochloride a foot

thick entirely cuts off the red end of the spectrum to D, so that, on placing in front of the tube one containing a strong solution of the perchloride, no light whatever passes. Mixing the two solutions produces no change, and the opacity is so complete that direct sun-light does not penetrate through it. We may thus readily explain why the protoxide combined with peroxide gives a black oxide; for one cuts off all the rays which the other transmits. Taking 12 as the width of the entire spectrum, a foot thick of protochloride also cuts off the blue end up to 2 below D, and only transmits bright green rays. On reducing the thickness to about 4 inches, one-half of the spectrum from the red end to D is cut off, but the blues and violet are slightly transmitted; and when the thickness is an inch or so, the whole of the blue end readily passes, though the extreme dull red is cut off for about $\frac{1}{4}$th of the distance to D. The crystallized salt acts in the same manner. So far as I have been able to ascertain, similar principles apply to the oxides of iron when combined with silica. Different kinds of bottle-glass show this very well. Since the intensity of the colouring due to a given amount of oxide may vary, it is impossible to do more than form an approximate conclusion as to the relative action of the two oxides in producing the colour; and it is in this sense that I shall speak of one or other preponderating. However, I think we may deduce the following conclusions:—If a mineral cuts off the blue end of the spectrum nearly to D, but transmits the red up to the extreme limit, there can be little or no water or protoxide present; whilst, on the contrary, if it contain little or no combined water, and be sufficiently coloured to cut off the red end halfway to D, and yet transmits all the blue, there must be very little peroxide present. If it cuts off all the red end to D, and yet transmits the green part of the spectrum, there must be relatively more protoxide than peroxide. If the blue end is cut off to near D, and also a considerable part of the red, so that only a narrow band of light is transmitted above and just below D, unless much water be present, there must be a good deal of both peroxide and protoxide; whereas, if there is only a slight action at both ends of the spectrum, there cannot be much of either. For example (assuming that the colour is chiefly due to the oxides of iron), the red mica in a lava from the Lower Eifel transmits the extreme red, but cuts off half the spectrum from the blue end, and therefore nearly all the iron must exist as peroxide. Augite in a lava of Vesuvius, which has been melted *in situ*, whilst the surrounding rock remained nearly solid, cuts off a little of the extreme red and also half the entire spectrum from the blue end, and hence contains more per- than prot- oxide. Bright green chlorite in slate from Keswick cuts off about $\frac{1}{4}$ of the distance to D from the red end, and also $\frac{1}{4}$ of the whole spectrum at the blue end, and therefore contains relatively less per- than prot- oxide. Such facts might often be good checks on the results obtained by analysis, even if material enough for that purpose could be procured.

5. *Application of Polarized Light with the Spectrum.*

In employing polarized light with the spectrum, it is requisite to insert a Nicol's prism between the prism and the achromatic condenser, and to use another Nicol's prism as analyzer, over the eye-piece. If then, the polarizer and analyzer being so placed as to give a dark field, a plate of selenite or other doubly refracting crystal be so arranged on the stage of the microscope as to bring its maximum power of depolarization into play, we see a spectrum of the usual colours, crossed at equal intervals by black interference bands, shaded off quickly on each side to the neighbouring colour. The number of these bands depends on the thickness of the plate. Thus, if, when examined with an ordinary polariscope, the colours are of the second order, there is one dark band in the spectrum; if of the sixth order, three bands; and if of higher orders, still more. But, as is well known, high orders are very faint reds and greens, and still higher mere white, so that a great difference in thickness makes no change in colour. When, however, examined with the spectrum and polarized light, the dark bands are very visible, and increase in number with the thickness of the selenite, until so numerous as to be undistinguishable. If, instead of comparing different thicknesses of the same mineral, we compare much the same thickness of different minerals, of course making allowance for difference in the position of the principal axis of the fragments, the number of the bands indicates a difference in the power of double refraction, and therefore this character becomes useful in studying some branches of microscopic mineralogy. For example, microscopic fragments of quartz, topaz, and calcite, of much the same size, show respectively a very few, a moderate number, and very many bands; and in studying thin sections of rocks, two minerals which do not show any other characteristic difference, might be distinguished by this means.

6. *Detection of Blood-Stains.*

Passing from these almost purely scientific questions, I will now describe the application of the spectrum-microscope to a very practical subject, *viz.* the detection of blood-stains in criminal inquiries. The optical properties of blood have been described by Hoppe,* and in still greater detail by Professor Stokes.† Hoppe suggested that the peculiar and characteristic spectrum of fresh blood might be employed as a test, but the plan he proposed was to moisten the blood-stain with water and examine it direct; which of course could not be done, if it were on a highly-coloured fabric. Professor Stokes also suggested that the spectrum of deoxidized hæmatin might be employed for the purpose, but did not further develop the subject, being evidently desirous to investigate it chiefly in relation to chemistry, optics, and physiology. However, in considering the question, I soon became convinced that it deserved a most careful study with special

* 'Virchow's Archiv.' vol. xxiii. (1862) 446.
† 'Proceedings of R. S.' xiii. (1864) 355.

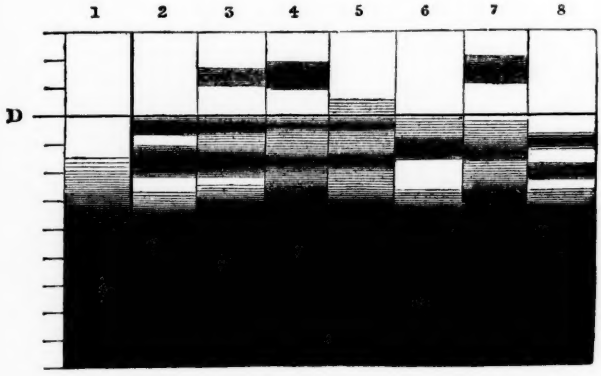
reference to the detection of minute traces of blood in criminal investigations, and therefore have directed a great amount of attention to that point alone. Such inquiries almost necessarily fall into the hands of a microscopist; and, as I shall show, the apparatus I have described will enable anyone to detect with certainty most marvelously minute traces of blood, when the usual methods would entirely fail. That merely chemical tests are generally suspicious, and often not to be trusted at all, is freely admitted by my friend Dr. Allan, who has had much experience in such inquiries; and, of course, if the red globules have been destroyed, the microscope alone is of little or no use. In such cases the method I now propose comes to our aid, and enables us to detect as small a quantity as $\frac{1}{10000}$th of a grain of the colouring matter of blood, left on a fabric from which apparently all traces have been washed, or which only shows a slight discoloration. If all has been washed out its detection is no longer possible; for it is this colouring-matter itself, and not any action on the material, that proves the former presence of blood.

Since in studying the spectra of blood, it is important to be able to operate on small quantities, I have employed cells, cut from a barometer tube, having an external diameter of about $\frac{1}{2}$ inch, an internal diameter of $\frac{1}{8}$, and $\frac{1}{2}$ inch long, slightly polished at both ends. These may be fixed with Canada balsam in the centre of pieces of glass about 1·6 square, or what is still better, in the centre of the longer side of triangular pieces, formed by cutting such squares along a diagonal, so that two may be placed side by side in front of the slit, and the spectra of two solutions compared together at one view. Liquids can be readily introduced into such cells by means of a moderately stout platinum wire; and, when rather more than full, so that a little spreads over the top of the cell, a piece of thin glass can be easily put on without inclosing any bubble, and the surplus removed with blotting-paper. Capillary attraction keeps the glass on, and evaporation takes place so slowly, that everything remains for a considerable time in a proper condition; and, if desirable, the glass may be fixed on by means of gold-size, and the solution kept for weeks. Placing such a cell in front of the slit, as at *a* in Fig. 1, the light passes through the thin glass at the top, through the column of liquid and the thick glass at the bottom, and then through the narrow slit to the prism. Cells of less diameter than $\frac{1}{8}$ of an inch might be used, but it is difficult to fill and empty them. Even when $\frac{1}{8}$ in diameter, if it be requisite to transfer the solution to a watch-glass, it is well to have a piece of such tube as is used for spirit-thermometers, drawn out at one end and bent at a right angle, so that it may be introduced to the top of the cell, and the liquid removed by blowing down the tube.

The exact position of the dark absorption-bands in the spectra obtained from blood being a very important character, it is necessary to make use of the micrometer; and I have found that for this purpose it is well to arrange the instrument so that the width of the entire spectrum is about 12, as shown by the divisions on the left hand side of Fig. 2. I shall adopt this method of measurement in all

my descriptions. Gas-lamp light is, if anything, better than daylight, because the line C of Fraunhofer interferes with the correct determination of some facts. Turning a wire holding common salt into the flame, the bright yellow sodium line is seen; and one of the principal lines of the micrometer having been made to bisect it, the wire is turned out of the flame and the measurements made.

FIG. 2.—*Blood Spectra.*



Since human life might depend on the accurate determination of the facts, I shall describe all the characteristic peculiarities of the spectra, so as to avoid, as far as possible, any serious mistake. If a piece of linen $\frac{1}{8}$ or $\frac{1}{10}$th of an inch square, soaked with blood, and quite recently dried in pure air, be digested in a few drops of water in a watch-glass, it yields a solution, which, when introduced into one of the cells just described, produces a spectrum like No. 2 in Fig. 2. The blue end is quite absorbed, and so are two bands in the green, but the whole of the red end is transmitted. When the solution is stronger, the absorbed portion of the spectrum increases upwards, and the dark bands in the green become broader, until the whole of the light below D is absorbed, and merely a bright red remains above it. If examined when the yellow sodium line is present a narrow dark band is seen just above it, even when the spectrum is like No. 2, and shows no such dark band in that position with the natural light. On diluting the solution the bands in the green become more and more narrow and faint, but do not disappear until it is so dilute that the blue end of the spectrum is transmitted without sensible alteration. Since the width of the bands varies with the strength of the solution, the position of their edges is not constant, though that of their centre is nearly so, and will be given in the following descriptions. However, it is somewhat difficult to determine it with great accuracy, on account of the gradual shading off on each side, which of course can be only imperfectly represented by a woodcut. Taking the whole

spectrum at 12, the centre of the upper band is at $\frac{1}{3}$ or ·4; of the lower, $1\frac{2}{3}$; and of the green between them 1. The upper band has a sharper outline, and, when so much blood is present as to cut off about $\frac{1}{2}$ of the spectrum, its width is about $\frac{2}{3}$ that of the lower, as shown by No. 2. As a good example of an entirely different spectrum, given by a solution of very similar colour, I refer to No. 1, which represents that of a dilute solution of perchloride of iron to which a little sulphocyanide of potassium has been added. In its case the blue end of the spectrum is more and more absorbed, according to the strength of the solution, but no narrow, dark bands are formed in any part. The spectra of many red colouring-matters have this character, and therefore could not possibly be confounded with blood. Cochineal does indeed yield an absorption band in the same position as the lower in fresh blood, but it is extremely faint, and there is none where the upper band occurs. A second does exist, but it is $3\frac{1}{4}$ below D, and is seen only when the solution is so dilute that the blue part of the spectrum is freely transmitted. On adding ammonia to the solution of cochineal, two absorption bands are produced, in such a position that without care they might be confounded with those of blood; but the upper is decidedly broader than the lower, whilst it is the reverse in blood; and its centre is also lower, being $\frac{1}{2}$ and not $\frac{1}{3}$ from D. A solution of cudbear in dilute alcohol also yields two very faint bands in much the same place as those in fresh blood, but on adding ammonia the band at $\frac{1}{2}$ becomes very dark and distinct, and the lower band vanishes. The addition of ammonia to a solution of fresh blood produces no such changes.

The gravy of roasted meat gives different spectra according to circumstances. The red liquid, which comes from it when undercooked, is merely a solution of cruorine, and gives the same spectrum as fresh blood; but the usual light or darker brown liquid sometimes gives a dark and sharply-defined absorption-band at about 1·4 below D, and suddenly cuts off all the rays below $2\frac{1}{4}$. The addition of ammonia causes a precipitate, but leaves an obscure band in the same situation. Citric acid removes the band entirely, but ammonia in excess restores it without causing a precipitate; and the addition of protosulphate of iron produces no change. When dried and strongly heated, the colour becomes darker, and it merely cuts off more or less of the blue end of the spectrum, as in No. 1, without there being any detached absorption-bands. Probably this is why dark-coloured gravy often has that character. Thus, though, as far as tests are concerned, the chemical composition is almost identical with that of blood, the optical characters and the manner in which gravy behaves with reagents, suffice to distinguish it; unless it be from meat so extremely underdone, that it is in fact merely more or less modified blood.

If blood be dried on white linen, and exposed to the air, the bright scarlet colour changes by degrees into brown. This fact must be well known, but so far as I am aware, has not been studied optically or chemically. When the change has not proceeded far, the blood yields a spectrum like that shown by No. 3. The two well-marked bands in the green are much the same as in fresh blood; but there is

also one in the red, having its centre at $1\frac{1}{3}$ above D; and therefore a trifle lower than Fraunhofer's line C. The intensity of this band shows the amount of change; and, when it has become complete, the spectrum is very different from that of fresh blood, as shown by No. 4. In this change the bands below D in the green become more and more faint, especially the upper, which finally is only just visible. A larger quantity of blood is required to show spectrum No. 4, than to show No. 2; and if the solution be strong enough, only a dirty-brown red light is transmitted, with a dark band in its centre. When kept under similar conditions, the extent of this change serves to show the length of time since the blood was fresh; and at one time I hoped that by this means it would be possible to determine the time with some confidence, which would often have been very valuable in criminal inquiries. In some cases it might, indeed, be made available, but in and near a town it could not be relied on at all. When sealed up in a glass tube in a perfectly dry state on linen, it would give such a spectrum as No. 3, after having been kept for two or three months; but when sealed up wet, there is apparently little or no such change. It thus appears that it partly depends on being dry, but will take place independently of being exposed to atmospheric influences. These, however, greatly accelerate it. Exposed to the air on Burbage moor, six miles from Sheffield, and about 1,000 feet higher, one or two miles from any house, the change took place more rapidly, so that the spectrum was nearly as No. 3, after a week or so; whereas in the centre of the town as much action took place in a few hours. Kept in the house, the rate of change varies very much accordingly as gas is burned in the room or not; and, when I had ascertained this fact, I concluded that it must be due either to carbonic or sulphurous acid. I therefore kept some in a flask with carbonic acid, without being able to perceive any marked effect, whereas sulphurous acid disseminated in a large quantity of air, turned it brown very soon, and caused the spectrum to change from No. 2 to Nos. 3 and 4; but, if much acid be present, it produces a more complete decomposition, and the absorption-bands are not so distinctly visible. It appears, therefore, that this change in the colouring-matter takes place in dry blood, whether exposed to the air or not, but is greatly accelerated by free exposure to fresh air, and especially by the presence of the sulphurous acid produced by the combustion of coal or gas. Light appears to have little or no influence. Carrying out the nomenclature of Professor Stokes,* I suggest that the brown colouring matter thus produced, should be called "brown cruorine." Though it is apparently dissolved by water, and yields a clear solution, yet it is doubtful whether it is soluble in the most strict sense of that term. Close-grained filtering paper removes a great part, and on standing for some time the finer particles collect and subside. It is also difficult to dissolve it from linen, or similar material without repeatedly moistening and squeezing it with forceps, so as to detach the minute particles, some of which remain quite firmly attached; and

* 'Proceed. R. S.' xiii. 355.

on the whole it is an excellent example of a connecting link between substances that are really dissolved by water, and those which can only be disseminated through it in comparatively large particles.

If ammonia be added to a solution which would give such a spectrum as No. 4, we obtain one like No. 5. The band in the red disappears, those in the green become far more distinct, and the spectrum is similar to that of fresh blood, only the bands are more faint, and it is slightly shaded up to ½ above D.

If a small quantity of a strong solution of this brown cruorine be placed on a piece of glass, and allowed to evaporate slowly, the greater part collects as a dry film round the outside of the drop; and, when examined on the stage of the microscope, it yields a spectrum like 4 or 5, accordingly as it is damp or quite dry. If dry, the spectrum is very similar to that of fresh blood, only the absorption-bands are less distinct; but, when breathed on, so that it may again become damp, the dark band in the red makes its appearance, and those in the green become more faint. These changes take place over and over again, though they gradually cease after some days; and hence it would appear that the dark band in the red depends on the presence of moisture, and may be due to the formation of some hydrous compound, decomposed on drying. The scarlet cruorine of fresh blood, treated in the same manner, exhibits no such changes, and gives the same spectrum as its solution in water.

Drying solutions of blood on glass in this manner gives very satisfactory results, and specimens so prepared may be kept in that state, or under thin glass fixed down with Canada balsam, without there being any sensible alteration after above half-a-year. The solution may be placed on a small square of thin glass till it has evaporated and become reduced to a drop or so, and then, having redissolved the dry part in the liquid, it may be allowed to run off at one corner to the glass on which it is to be kept, leaving the minute foreign fragments behind. If, however, the mordants used in dying the fabric have changed the blood to hæmatin, the results are not satisfactory. A solution of fresh blood mounted in a cell still gives the characteristic spectrum after some months, though more faintly than at first. Brown cruorine soon forms a deposit, and loses its character when thus kept.

Professor Stokes has described the change produced by the action of deoxidizing agents on fresh blood. Whether the cruorine be fresh and scarlet, or have been more or less converted into the brown modification, if citrate of ammonia be added to an alkaline solution, so as to prevent the precipitation of oxide of iron, and then, having introduced it into a cell, if a small piece of crystallized protosulphate of iron be added, and broken up and stirred till dissolved with a platinum wire flattened at one end and bent at right angles so as to form a sort of little hoe, we obtain the spectrum No. 6. There is one well-marked absorption-band, the centre of which is 1⅓ below D, and a general shading upwards as far as D. Hence it is clear that the change from scarlet to brown cruorine is not of such a nature as to prevent both from yielding the same spectrum when deoxidized; or,

as described just below, from most readily passing into hæmatin, when acted on by a weak acid. So far I have been unable to decide whether the difference consists in brown cruorine containing more oxygen or water, or in its being only an isomeric modification of the scarlet. However, since such a powerful oxidizing agent as permanganate of potash does not produce it, and since it is not formed in solution or when damp, the latter supposition appears to me to be the most probable, unless indeed it contains less water.

Professor Stokes has shown that weak acids convert cruorine into hæmatin,* and has described the spectrum produced by it in its natural state, and when alkaline and deoxidized. On adding acetic acid to a solution of either scarlet or brown cruorine, a spectrum is obtained like that shown by No. 7. There is a well-marked absorption-band in the red, the centre being situated at $1\frac{1}{2}$ above D, and therefore rather higher than that in the case of brown cruorine, and very nearly in the position of Fraunhofer's line C. There is also another at about 1·4 below D, and perhaps a third still lower, which is only seen when the solution is more dilute, and even then so obscurely that its existence appears doubtful. When dried on glass the band in the red does not disappear; and when the solution is strong, ammonia causes a precipitate, as though hæmatin were much less soluble in ammonia than either scarlet or brown cruorine. However, the solution being somewhat dilute, using about $\frac{1}{3}$rd or $\frac{1}{4}$th of a grain of citric acid to prevent the subsequent precipitation of oxide of iron, adding ammonia in decided excess, and introducing the whole into a cell; if about $\frac{1}{20}$th or $\frac{1}{30}$th of a grain of crystallized protosulphate of iron be dissolved in the solution, we obtain the very well-defined spectrum of deoxidized hæmatin shown by No. 8. The centre of the upper band is $\frac{7}{8}$ below D, and of the lower at 2. The upper is about $\frac{1}{4}$ wide, very dark, and sharply defined; the lower nearly the same width, but much more faint. Neither is much shaded at the edges, and both vary more in darkness than in width, on increasing or decreasing the strength of the solution or the length of the cell in which it is examined. When concentrated, and in a tube $\frac{1}{4}$ an inch long, the width of the bands is much as shown, but the shaded part is darker. In a tube $\frac{1}{8}$th of an inch in diameter, a spectrum as distinct as No. 8 is given by $\frac{1}{100}$th of a grain of liquid blood, making on thin linen a spot about $\frac{1}{10}$th of an inch in diameter; and such a minute quantity will show the bands faintly, yet distinctly, that $\frac{1}{1000}$th of a grain of liquid blood would be quite enough to furnish us with unmistakable evidence of its presence, if some little care and trouble were taken over the experiment, and the solution examined in a cell not more than $\frac{1}{10}$th of an inch in diameter.

It thus appears that in various conditions blood yields no less than eight very different spectra. At all events, we can most readily get four or five, so characteristic, that with proper care there could be no fear of confounding it with any other substance that I have hitherto examined, and probably not with any in existence. However, in all

* 'Proceed. R. S.' xiii. 357.

important investigations, it would be advisable to examine the spectra of any substance likely to be present. I would also specially insist on the importance of carefully attending to the exact position and character of the absorption-bands; and before anyone gave evidence on such a subject, that he should make himself practically familiar with the facts I have described.

In applying this method to the detection of blood-stains on various articles of clothing, it is requisite to ascertain the effect of the different materials, dyes, and mordants. I have for this purpose made a great many experiments, and yet probably much remains to be learned. As a general rule, the dyes exercise little or no prejudicial influence; but when alum has been used as a mordant, it produces an effect which might easily mislead. Hitherto I have not been able to overcome the effect of the tannin in different sorts of leather. They precipitate the colouring-matter of the blood, and no spectra can be obtained. If, indeed, the blood can be scraped off from the surface without any considerable amount of leather, it can be detected as usual; but, if it had been sponged or washed, probably no trace whatever could be detected. The same applies in the case of those woods, which, like oak, contain tannic acid. Vegetable soil, when its amount is large in proportion to that of the blood, also precipitates the colouring-matter in an insoluble form; but, where the relative amount is small, as on dirty clothes, it does not sensibly interfere with the test, though it tends to impair its delicacy.

When scarlet or brown cruorine is acted on by a solution of alum, it is converted into hæmatin. If it has been used as a mordant, sometimes a portion remains in such a condition as to produce this change in blood-stains; and, moreover, the alumina may combine with the colouring-matter of the blood, and make it insoluble. In such cases it is impossible to obtain the spectrum of either scarlet or brown cruorine; but if a piece of cloth, mordanted in this manner, marked with blood, be digested in a few drops of water in a watch-glass, and repeatedly squeezed with forceps, a turbid solution is obtained, which, treated with citric acid, filtered, rendered alkaline with ammonia, and deoxidized with protosulphate of iron, shows quite well the spectrum of deoxidized hæmatin No. 8.

In a few cases the colouring-matter of the dye is slightly dissolved by water. I have especially noticed this in the case of black printed calico; and if much of such material, containing very little blood, be digested in water, the dye may cut off the characteristic part of the spectrum. Care should therefore be taken not to use any of the material not well marked with blood, and to have the solution so dilute that the dye may not cut off the green rays.

Almost everyone must have noticed the fact that, when a blood-stain on white linen or calico has been exposed to pure air for only a short time, it can be almost entirely dissolved out by water; but, if dried and exposed for some time, the imperfectly soluble brown cruorine cannot be entirely removed, and leaves a brown stain, which, though readily seen on white material, might be scarcely visible on coloured or black. However, on digesting the suspected portion in a

few drops of water with citric acid in a watch-glass, and proceeding as already described, a most unmistakable spectrum like No. 8 may be obtained, even when the stain is only half-an-inch square, and scarcely visible. In attempting to remove a blood-stain from cloth by sponging, on the first application of the water a solution of blood would be formed, and run into the surrounding cloth by capillary attraction. Hence, though the stain may appear to have been removed, the cloth round about might, and probably would, retain abundance of the colouring matter, which could be dissolved out. Any suspicious marks that might be due to such treatment should therefore be examined with care. Of course, in such cases the microscope alone would be of no avail, and mere chemical tests could not be relied on, and thus the spectrum method becomes especially useful. Specimens of this character having been placed in the hands of some of the first authorities in such inquiries, they said that neither they nor anyone else could make out anything from them; nor would they believe that I could, though the amount of blood was such that in a few minutes I could have shown such a spectrum as No. 8, and have been in a position to give evidence with great confidence.

When soap is present it causes a precipitate; but this is quite soluble in plenty of ammonia, and does not prevent our seeing the spectrum No. 8. Boiling water, instead of facilitating the removal of blood, makes it more fixed, by coagulating the albumen. If the blood be dried on glass, the colour is changed to a brownish red, and it gives a spectrum like No. 5, whether dry or damp. When dissolved by citric acid, it yields hæmatin, and readily gives spectrum No. 8.

In some cases foreign matters, or the mordants, make the solution so turbid that it is difficult to see the spectrum to advantage. If we wish to observe the spectrum of blood in its natural state, or as it becomes by mere exposure to the atmosphere, it is better not to filter, but to allow the solution to stand in the cell in front of the slit, until it has become sufficiently clear; because filtering would probably remove much of the colouring-matter of the blood. However, in some varieties of brown cloth the mordants give rise to such a turbid solution, that it is very difficult to see the spectrum in a satisfactory manner. Citric acid should therefore be added to make the colouring-matter more completely soluble, and the liquid filtered. For such small quantities a blotting-paper filter ¾ of an inch in diameter should be used. It can be conveniently supported on a platinum wire bent at one end into a ring, and made to slide up and down a small wire for a support; and if the bottom of the filter touch the cell or watch-glass, though the liquid may pass through slowly, the final result is far more satisfactory. After the acid solution has passed, it is well to add the ammonia by allowing it also to go through the filter, to carry away any colouring-matter, soluble in that reagent, that might remain on the filter.

Though in actual practice many other facts may turn up to render special modifications necessary, yet the following is the method I should adopt in examining a mark or stain supposed to be due to blood, assuming that only a small quantity was at my disposal. I

should first cut off a portion of the material where *not* marked, and digest it in four or five drops of water in a watch-glass, squeezing it with forceps, and moistening it over and over again. If the solution became coloured, I should introduce it into a cell and determine the character of the spectrum, both in its natural state, and after having been acted on by the different reagents already mentioned. I should then add a very little blood to a few drops of water, and digest in that solution a small piece of the material, so as to make out whether it contained anything that acts on the colouring matter of blood. Having satisfied myself on these points, I should cut off a small bit of the stained portion, using from $\frac{1}{10}$th to $\frac{1}{4}$th of an inch square, according to the character of the mark, and the amount of material at my disposal, and digest it in three or four drops of water in a watch-glass. If the solution became well coloured, I should not squeeze the material so much as to detach many minute particles of foreign matter; but if there appeared to be very little colour present, I should dissolve from it all I could, and take care to waste as little solution as possible, and have no more than would properly fill the cell. Transferring the solution to a cell about $\frac{1}{2}$ inch long and $\frac{1}{8}$th inch in diameter, and having placed it horizontally in front of the slit, and left it a short time, so that the minute particles of foreign matter might settle to the lower side of the tube, I should examine the spectrum, and carefully note the exact position and general characters of the absorption-bands, if the solution were too strong, diluting it until they were well seen. If the spectrum were like No. 2, I should feel nearly sure that the mark was due to blood; and, if it had been kept dry in a town, I should also conclude that it was nearly fresh. If it were as No. 4, I should feel inclined to believe that it had been exposed to the air for some time; but, unfortunately, the character of the atmosphere makes so much difference that no rule can be given. If, however, in any particular instance a knowledge of the length of time that had elapsed since the blood was fresh were of importance, a more definite opinion might be formed after a few days' experiment with fresh blood, keeping it, if possible, under the same conditions, and using the same material as in the case in question. If the spectrum obtained was like No. 4, I should add ammonia in excess, so as to obtain one like No. 5, and afterwards add citric acid in excess, so as to see spectrum No. 7. Then adding excess of ammonia and a small quantity of protosulphate of iron, stirring it to dissolve all the oxide, but not so much as to peroxidize and make the solution so yellow that it would not transmit the green, the spectrum No. 8 would be well seen, even when a very small quantity of blood had been present. If plenty of material remained, I should take another portion, dissolve the blood from it, add citrate of ammonia, taking great care that the solution was never acid, and then deoxidize by means of a little protosulphate of iron, so as to obtain No. 6; and I should also mount a dry specimen on glass, to keep as a permanent proof. If all the characteristic results followed, I think no one could hesitate in giving evidence that the mark was blood; though, of course, these facts alone would not decide whether or not it was human—if possible, that must

be accomplished by other means, or a conclusion formed from other considerations.

If the quantity dissolved out at first gave a very faint spectrum, it would be well not to attempt to see the spectra Nos. 5, 6, and 7, but to act on the solution with citric acid, filtering, if requisite, and then to add ammonia and protosulphate of iron, so as to obtain No. 8. The material itself might also have so acted on the blood that no other spectrum could be seen. It is, however, so characteristic, that, even then, one could scarcely hesitate in deciding that the stain was due to blood.

If the material had evidently been washed, so that no spectrum could be obtained from a simple solution, having first ascertained what effect citric acid has on the dye, I should digest a stained portion in a solution of $\frac{1}{3}$rd or $\frac{1}{4}$th of a grain of citric acid in a few drops of water, so as not to have more liquid than will fill the cell, filter, if requisite, add excess of ammonia, and then protosulphate of iron. Unless very thoroughly washed out whilst the blood was quite fresh, no mere washing with hot or cold water without brushing or other mechanical means being adopted to dislodge the minute insoluble particles, will so completely remove the stain that it could not be detected in this manner; except, indeed, any of those foreign substances be present which precipitate the colouring-matter in a form insoluble in citric acid and ammonia.

Supposing a clear coloured solution be obtained, which gives a different spectrum or set of spectra to those characteristic of blood, it might be desirable to ascertain the nature of the substance to which they were really due. I have already described the spectra of a few colouring-matters, but in all cases I strongly recommend the study of the spectra of any substances likely to occur in any particular instance. Even if blood has been detected, this would also be desirable, since an opinion could then be given with more confidence.

My conclusion is, that, even in cases where the usual tests would fail, the detection of minute traces of blood need not in general be a weak point in the evidence of crime. Having proved it to be present, the question of its having been human or not must be decided by other considerations; and thus as a positive proof the evidence may be equivocal: but if a stain supposed to be due to blood, which, if it were, would certainly give the characteristic spectra, fail to do so, the negative evidence would be decisive.

7. *Conclusion.*

It is, of course, at first, always difficult to know to what subjects a new form of apparatus may be usefully applied; but I trust that the facts I have described will suffice to prove that, for so simple an addition, the resources of the microscope as an instrument of research are greatly increased by our being able to use it also as a spectroscope.

ON THE HEALTH OF METAL MINERS.

By R. Angus Smith, Ph.D., F.R.S.

Is it, after all, wonderful that a Royal Commission should inquire if the condition of miners is satisfactory? It seems to us that history is full of their sorrows.

When great armies stood before each other in ancient times, it was often to answer this serious question, "Which of us shall live in ease and abundance, and which shall die in the worst of bondage working in the mines?" The miners were always miserable, even if they lived in Attica itself, and but a few miles from the Exchange where the mine-shares were sold.

In our own times the same is repeated, and Poland stands before Russia to answer the question, "Shall we die in the mines?" It was surely by the forced labour of great masses that accumulated waste or *bings*, greater than are known to be raised in modern time, have been collected in Spain, and especially at Huelva. In all known places the work of the mines was once distressing; still a Commission may very well inquire into the mode of cure, as all the evils seem capable of a remedy. There has even been a period in modern history when the work of the mines has risen to be enthusiastically admired, and this spirit is not entirely gone from some districts.

When forced labour ceased, the mines became less deadly, and men who were not observant did not see that they still failed to reach a fair standard of health.

It is a curious thing that a population does not know, and can scarcely be taught, when it is unhealthy. Twenty years ago it was proved that the average age of all who died was, in some places in England, less by half than in others, and yet few people know it even now, but many are constantly boasting of the health of the very towns that were then branded, and have not improved.

The popular proof of the health of a given locality is frequently the attainment of great age by some individual in that locality, as if such a fact could prove either wholesomeness or unwholesomeness. We can only see the influence on masses, and when the thousands of figures necessary for the calculation are reduced to a few. Some close observers and men of fine instincts are to be excepted.

In the General Report on the labouring population, in 1842, by Mr. Edwin Chadwick, C.B., it is said—"On examining the condition of 1,033 men artisans (agricultural labourers), living and working in the vicinity, it was found that their average age was forty years, and that their average period of work then completed was twenty-five years." Of 2,145 miners, the average age was thirty, and they worked fifteen years. Of the mining population, one-third only had attained fifty years of age; of the non-mining, one-third had attained seventy years. This was on the authority of Mr. R. Lanyon, surgeon, in Cornwall.

This book of Mr. Chadwick's began the public sanitary movement which has not yet ceased.

The first view of metal miners is not favourable; they seem a distinct race of men, with complexions entirely new to us. We soon find that this is caused by a peculiar clay which gives their countenances a sallow look. There are, therefore, various appearances as the clay varies. Wash the clay off, and see the men on Sunday, there is still a difference, and "men of certain mines are known by their appearance," as is shown by the evidence of the Mining Commission.* We hope this remark alludes to their Sunday appearance, otherwise it is of less value.

Dr. Peacock says:—"It is impossible not to be struck with the peculiarly delicate appearance of some of them, and especially of the older men and boys, and young men who have worked underground only for a short time. Instead of having the bright and clear complexion of young people employed at the surface, those who labour in the mines have a pale, sallow appearance, and this they seem to acquire even after having worked underground only for a few months. For men following a laborious occupation, they are by no means muscular, and very generally their pulse at the wrist is feeble.

"If inquiry be made of them they frequently acknowledge that they are not in good health, complaining of dyspeptic symptoms, want of appetite, qualmishness, sense of weight or flatulency after taking food, sometimes pain at the pit of the stomach, and occasional vomiting of the food, and an uncertain state of the bowels, either confinement or diarrhœa. Very frequently, also, they suffer from pains in the back and failure of muscular power, or from breathlessness, especially on any active exertion, tightness of the chest, chronic cough and expectoration, and palpitation of the heart." One would think this quite sufficient, but Dr. Peacock gives as the diseases of miners—general debility, indigestion, rheumatism, &c., asthma, bronchitis, or pneumonia, or the two combined, and phthisis or tubercular consumption. To these are added such forms of diseases of the heart as are generally occasioned by any violent exertion, as rupture or injury of the aortic valves.

"Deafness is extremely common, and frequently exists in a marked degree in men who have worked several years underground, and this, too, when they have never sustained any injury from blasts or other accidents."

Dr. Peacock mentions the lowness of the pulse, and it is remarkable that in a series of experiments on breathing in confined air when an air-tight chamber was used, we found that the most striking result was a lowering of the pulse at the wrist. To this was added a rapid breathing. This occurred to such a degree as to lessen the amount of beats per minute by twenty, when it was considered safer to desist.

The habit of smoking, which is much indulged in by the miners, is probably caused by an instinctive desire to quicken the movements of the heart, and certainly this result is produced at the moment at least in some persons, whatever may be the ultimate effect.

If we were reviewing the Report of the Commission and the Ap-

* The report and evidence here referred to are published by the Royal Commission to inquire into the condition of all mines in Great Britain, to which the provisions of Act 2 & 3 Vict., cap. 151, do not apply.

pendix, we should say much concerning Dr. Peacock's Report. He has found, as all men do, when they go among metal miners, that the complaint against bad air is constant. He says—"I have been repeatedly told by miners now at work that all miners have to breathe bad air more or less; or that in all mines there are places where the air is bad." In one place he met several men obliged to give up work for the day on account of the air. "They said that the bad air made them dizzy, sometimes adding, 'as if they had been in liquor,' caused violent headache, and made them feel sleepy, so that they could scarcely keep awake, and took all the power out of their limbs. Sometimes they said they became quite faint; and I was told the men had occasionally fits when working in bad air, and had to be carried out."

Mr. Bankart, of Guy's Hospital, finds also complaints concerning the bad air and defective ventilation; both mean the same thing.

In 150 cases of disease among the miners, he found 102 in the respiratory organs, and 16 in the heart.

Dr. Peacock's results are in the 'West Cornwall Report' (p. 9); Mr. Bankart's are from Cornwall (p. 96).

This medical evidence from experienced men who studied the matter on the spot cannot be overvalued. Let us now look at another kind of evidence, that of figures; and here Dr. Farr comes with his inexorable tables. One cannot wonder enough at these results; they tell the health of a district, as we tell the hour of the day by looking at the figure to which the hand points. Perhaps every illness leaves its mark on the death-rate, and perhaps every joy and every anxiety of mind lie there explained, if we could but read them.

Cornwall is a healthy district, washed by the pure winds and rains of the Atlantic; if the race had any vigour, it must there be nourished, and so we find it.

Dr. Farr finds that the mortality in Cornwall of the male children under five years of age is 55 per 1,000; whilst in Norfolk, an agricultural district, it is 65. Cornwall is, therefore, very excellent for the health of children or it produces very healthy children; in any case, speaking highly of it in a sanitary point of view. The mortality of all under fifteen years of age, of miners and others, is less than the mortality at the same age in Norfolk. Besides this, "the children and the women of these districts enjoy as good health as the children and the women of Norfolk, or any of the other counties."

People like to hear their impressions confirmed by statistics. It has been said that no one can go into Cornwall without observing the very healthy countenances on one side, perhaps because contrasted with those of the miners on the other.

Dr. Farr says that the mortality in Cornwall begins to be excessive at the age of thirty-five. A frequent cause of death is consumption, but as it does not appear hereditary, it is supposed not to be the ordinary disease of that name. (P. 157, the Appendix B., same Report).

The following tables are abridged from those of Dr. Farr. (The headings for the columns in Table A apply also to the corresponding columns in B).

A.—*After-lifetime of Males, or Years of Life after the Age of* 20.

Age.	Males of all Classes.		Miners.			
	Healthy Country Districts.	England and Wales.	Cornish Districts.	Stafford-shire Districts.	Durham and Northumber-land Districts.	Merthyr Tydfil District.
	Years.	Years.	Years	Years.	Years.	Years.
20	43·456	39·425	34·862	33·307	42·016	30·575
30	36·483	32·681	27·755	27·706	34·563	24·841
40	29·342	26·018	20·314	21·644	27·387	19·765
50	22·078	19·545	14·064	15·666	20·447	14·463
60	15·094	13·614	9·688	10·530	13·772	9·079
70	9·356	8·524	6·131	6·502	7·927	5·535
80	5·378	4·992	3·501	4·117	4·196	3·934

B.—*Healthy After-lifetime, or Years of Health after the Age of* 20.

TOTAL . . .	40·5	36·4	31·9	30.3	39·0	27·6
20 to 40 Athletic age	18·0	17·6	17·7	16·5	18·2	16·1
40 to 60 Intellectual age	14·6	13·0	11·5	10·7	14·2	9·4
60 to 70 Mature age	7·4	5·6	2·7	3·0	6·4	2·1
80 & upwards, Monumental age	·5	·2	·0	·1	·2	·0

The deaths by violence in metal mines are not so numerous as one might expect. In copper, tin, lead, and iron mines, the amount is 109 out of 100,000.

Of 382 cases (p. 157, Dr. Farr's evidence), there were—

Crushed or injured by fall of stone	149
Fell into the pit	122
By blasting	39
By drowning	13
Other methods of violence	59
	382 = 109 in 100,000

In coal mines the number is much greater.

Crushed by fall of coal	236
Explosions	145
Falls in the pit or shaft	92
Blasting	5
Drowning	4
Other causes	16
	498 in 100,000

The same evidence adds that deaths by explosions are only 145, and yet they horrify us the most. We forget the 236 who are being crushed by falls of stone, caused mostly by ignorance or carelessness.

We see that the greatest loss of life begins at the age called by Dr. Farr the "intellectual." There we find that something like a fourth of the time when the intellect is most powerful, is cut off from those men, and two-thirds of the maturer age.

There is not found in the habits of the people, at least in Cornwall, anything to account for these unhappy conditions. Their food may not be the most wholesome that can be obtained, but it is better than the food of some who do not so suffer. This we believe, but cannot enter upon the subject. It is, however, enough to say that the great health of the women and children shows that the evil is not to be found in the food being imperfect.

We must leave others to find out the unhappy and unwholesome dwellings if these exist in greater numbers than elsewhere.

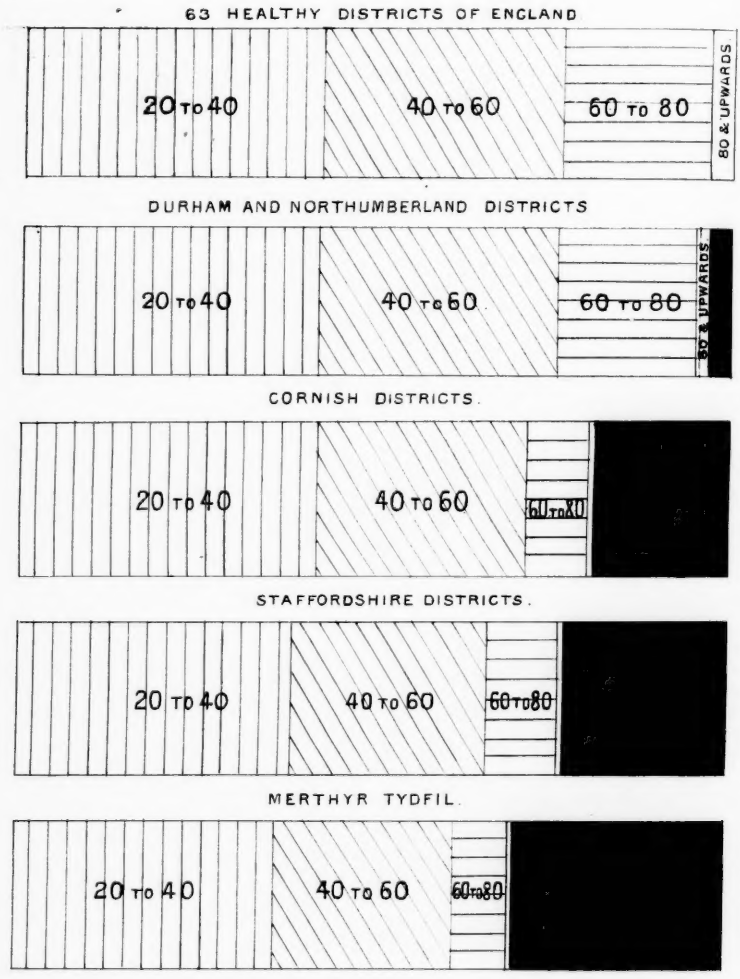
With the behaviour and character of the people we were much pleased, not having ever met a population in apparently better condition.

The great distance of the dwelling-house from the mine is a point of very great importance to the workmen, and yet this inconvenience is almost unavoidable when new mines open. The proprietors may find that they would gain by conveying the men by railway or omnibus. We now know better than formerly that nothing is to be gained by overdriving or overworking; although this is not complained of at the mines. Overwork is done to a great extent willingly, and it will always be done where there is a high-spirited people. The long walks are a species of overwork, which, however, we can scarcely lay to the charge of the employer.

Out of 10,000 who attain the age of fifteen, there were registered as dying:—

	England generally.	Miners.			
		Cornwall.	Stafford.	Durham.	S. Wales.
Diarrhœa and Cholera . . .	547	230	1,052	1,255	1,915
Fever	426	324	385	307	782
Diseased Heart and Dropsy . .	928	484	612	928	333
Consumption	1,523	4,439	680	948	1,604
Other Lung Disease	1,343	1,157	1,975	1,010	1,433
Accident or Violence	532	782	2,782	1,312	2,158
All Lung Disease	2,866	5,596	2,655	1,958	3,037
Lung Disease and Accident . .	3,498	6,378	5,437	3,270	5,195

It is to be observed that Dr. Barham and Mr. Hunt consider that the effect of the mines is seen at an earlier age than shown by Dr. Farr's statistics. The health seems to suffer some time before the death-rate takes notice. Dr. Peacock also considers that the mines



Dr FARRS DIAGRAMS OF THE PROPORTIONAL NUMBERS OF MINERS, LIVING AT 4 PERIODS OF LIFE, IN 4 MINING DISTRICTS, COMPARED WITH 63 HEALTHY DISTRICTS.

affect the young, and we might collect evidence to this effect from other countries. On this we cannot enter.

The expense of such a low state of health may be more striking to some persons than the enumeration of the years of life.

By the following table we find the difficulty of insurance, which is the more to be lamented, as the miners must be a provident people. Dr. George Smith says that there are 800 houses in Camborne the property of labouring men, nearly all miners. The following is part of another table by Dr. Farr :—

Age.	Single Premium which will Insure 100*l.*, or Life Insurance at 8 per cent.			Annual Premium which will Insure 100*l.*, or Life Insurance at 3 per cent.		
	Healthy Districts, Males.	All England, Males.	Cornish Miners.	Healthy Districts, Males.	All England, Males.	Cornish Miners.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
20	32 3 5	35 14 11	39 4 10	1 7 7	1 12 5	1 17 0
30	37 11 7	41 14 1	36 14 5	1 15 1	2 1 8	2 11 0

It is probable that the diagrams of Dr. Farr (*see* plate) will illustrate the subject more clearly than any of the tables. We see the lifetime of healthy males in England in the first diagram ; in the second there is a dark space with no lines ; in Cornwall that space greatly increases, and in Merthyr Tydfil takes up a third of the ground. Take also middle and old age—the space gradually diminishes. We hope that some one will write on the social condition of those people. We believe that in Cornwall there is found a class who have made such advances as are very rare.

The sum of the argument is, that Cornwall is an extremely healthy county ; that the general population is very long-lived ; that the miners are a very short-lived race ; that the social habits of the miners are not such as can account for the great diminution of the length of life, which is due consequently to the condition and work of the miners.

The Air of the Mines.—If the evidence against the ladders is great,* that against the air is great also. In all inquiries there are men who have particular favourites among the various views of a subject. They desire that one side shall be the winner, and for no reason that they can give. We think the cause is this :—they admire that which they first learnt or understood, and especially if they thought of it themselves. It is the same as bigotry or superstition. We have a curious instance of it in seeking the causes of disease in Cornwall. Some persons would not understand what miners' consumption meant, —would not acknowledge having heard of it. Others, and these are many, do not believe in the existence of unwholesome air, and trace everything to the ladders, forgetting that the miners' disease is cen-

* *See* p. 63, No. 5 of this Journal.

turies old, and existed before great depths were attained—forgetting too, that the air is not bad in proportion to the depth—forgetting too, that unerring instinct of the miner which for ages has led him to fear the foul air and the "demon of the mine," which sometimes strikes him suddenly dead with his foul breath.* The greatest evils from the air are felt when the men are down the mine, not after they have risen to the surface and are suffering from fatigue; but the great depth may and does cause some of the most dangerous symptoms after the exhaustion of mounting. Let us be satisfied that every evil demands a cure, and if one evil be somewhat smaller than another, let us nevertheless seek to eradicate it. We believe the greatest evil to be foul air; perhaps also, from some bigoted feeling, and perhaps because we know most about it; but we cannot cease to admire him who diminishes the labour of mounting the ladder steps.

The author of this paper examined the air of the mines and has given, in his report, an analysis of several hundred specimens. This report begins first by inquiring into the composition of the air. Hitherto it has been given with differences of one-tenth per cent., or one thousandth part, forgetting how much one in a thousand of air is, and that we can trace in a moment the presence of some substances even to a millionth, perhaps far beyond this. The air at various times and in various places was found to differ in the amount of oxygen. The author does not suppose that the loss of the minute amounts of oxygen in some of these cases is of consequence, except as an indication of the presence of other gases. It may even be that in the higher numbers with small differences some uncertainty exists, but as a whole, the gradation in the following table came out after arranging five or six hundred analyses, and was entirely unexpected.

Analyses of air varying in the amount of oxygen (per cent.):—

N.E. Seashore and open heath of Scotland	20·999
Tops of hills—Scotland	20·98
Base of hills—Scotland	
Suburb of Manchester in wet weather	20·98
Front Street—¾ mile from Exchange—dry	20·945
Back of house	20·936
Unhealthy parts of Perth—favourable or windy day	20·935
Fog and frost in Manchester	20·91
Sitting-room which felt close	20·89
After six hours of a petroleum lamp	20·83
Pit of Theatre	20·74
Gallery	20·36
When candles go out	18·5
Difficult to remain in	17·2

This table is given in order to enable us to compare the air of mines with purest air and with ordinary bad ventilation. The closest gallery of a theatre did not lose above one-third the amount of oxygen lost in the average of all the mine air. How low the amount must in many cases have been to produce this low average may be imagined,

* If this seems only a metaphor it was none to the old miners, who have left descriptions of several species of demons.

and, as far as figures show, it may also be seen in the report alluded to, and in part in the above table.

Summary of the Analyses of Air in Mines.—Oxygen.

Average in 339 specimens	20·26
Lowest	18·27
Average in large spaces	20·77
Currents	20·65
Just under shafts	20·424
In ends	20·18
In sumps	20·14
In all other places	20·32

Air with 20·9 of oxygen was assumed as normal, or nearly so, although the figure is too low. Air with less than 20·6 was assumed as exceedingly bad, because it is not equalled in our most suffocating assemblies.

Let us compare the mine-air with the atmosphere of various places in relation to carbonic acid.

Analyses of atmospheres varying in carbonic acid.

	Average Carbonic Acid per cent.
Manchester streets—usual	0·0403
During fogs	0·0679
About middens	0·0774
Average	0·0442
Fogs excepted	0·0424
Fogs and middens excepted	0·0403
Where the fields begin	0·0369
In close buildings	0·1604
Minimum of suburbs	0·0291
Over North Scotland (towns excepted)	0·0336
Candle goes out	1·8 to 2·5000
Lowest found in mines	2·5000
Lowest entered for experiment	4·0000
Average of the mines	0·7850

These figures may be read as whole numbers; for example, average of the mines, 7,850 in a million.

And why should we be afraid of a little carbonic acid? Because carbonic acid deranges the circulation, causing at first sometimes a rapid beating of the heart, but ultimately a very low and weak pulse, and a quickened respiration, although at times a somewhat slower respiration. It is never indifferent, and the effect may be traced when even so little carbonic acid exists as one-tenth per cent. This is a sufficient reason for ventilating and for seeking pure air.

Chemists have often asserted that foul and pure air have the same composition; this need no more be repeated.

Calculated Composition of the Air of Mines in some Places.—If we put together all the substances thrown into the air when two miners are working in a space equal to 1,200 cubic feet, we have as air and impurities together—

	Grammes.	Grains.
Oxygen	9048·957	139737·7945
Nitrogen	33726·7	520470·4
Carbonic acid . . .	1200·44	18525·2
Carbonic oxide . . .	3·188	49·2
Hydrogen	0·07186	1·1088
Sulph. hydrogen . . .	0·59869	9·23898
Sulphate of potash . .	144·760	2233·936
Carbonate of potash . .	43·311	668·375
Hyposulphite of potassium .	11·189	172·668
Sulphide of potassium .	7·296	112·592
Sulphocyanide of do. . .	1·049	16·186
Nitrate of do. . . .	12·751	196·773
Carbon	2·494	38·482
Sulphur	0·466	7·191
3/2 carbonate of ammonia .	9·790	151·079
Organic matter . . .		
Sand		
Sulphurous acid, or . .		
Sulphite of ammonia . .		
Arsenious acid . . .		

Organic and Solid Matter.—The reason we feel ill in air having only from one to two-tenths of carbonic acid, is mainly owing to the organic matter by which it is accompanied. The mines contain such organic matter also, and if not in the same proportion as in crowded rooms, there are other substances, as we have seen, which make up for it. If we are suddenly brought into a crowded room, it is very unpleasant; but if the room is emptied, and the air has time to change, it is not less unpleasant to breathe for some time, because of the organic matter which has been left clinging to everything. Mine air, however, is still worse; if you take a cubic inch of it away to a spot where the air is pure, and then breathe it, you will have obtained a good specimen, if you do not smell grease, tobacco, and sourish perspiration, or you may perhaps consider it a little putrid. We never go at once into a mine; we can only go gradually. How dreadful to be launched at once into an atmosphere, a cubic inch of which is more than enough to give rise to unpleasant sensations to half-a-dozen persons! Yet such air exists in the mines.

Smoke and Dust.—But these things are not all. There is in the air a great abundance of solid substances. These are found on the sides of the tubes of collected air, and were examined by the microscope. They consist of sand and of carbon, but also of crystals of sulphate and nitrate of potash. The sulphide of potassium goes into sulphate, and some of the gunpowder is not decomposed. The men breathe these continually.

Sometimes at dead ends or extremities of levels, especially when there is a rise, the air is such that no man can work above ten minutes, and they take it in turns. So we have been told by miners; we have not been in such places in mines, but we do not feel surprised at the assertion.

Water and Boilers.—We can only say a few words on boilers.

In the evidence adduced by the Commissioners we are surprised to hear that the boiler is considered so unusually dangerous; it is true we have found sulphate of copper in water used for raising steam, but surely this cannot be commonly used in Cornwall. Water such as that is most destructive, as it dissolves the iron rapidly.

Whilst speaking of this subject, we may mention the very beautiful discovery of young Dr. Bischoff, of Bonn. He finds that the oxide of iron, of which there is so much where pyrites is burned, can in a very moderate heat be converted by carbon into metallic iron, still retaining its fine texture. Water passed through this is freed from copper in an instant. This may in some places be found a valuable process. It is not absurd to expect that the process may be available, so far as to bring drinking water within the nearer reach of some of the miners, because, if the copper is removed, it is easier to remove the iron.

We shall be asked, What interest can there be in providing water for a county like Cornwall, in which the winds from every quarter are said to bring rain? But, true as this may be, we have found persons going two miles for water to drink. The streams are poisoned, and the carriage of water is one of the greatest burdens on the poor of some districts.

How do Miners know that the Air is Bad?—They actually wait to see if a candle will burn in it. Let us imagine people in a ball-room saying, "This room is well fitted for dancing, and is well ventilated, because the lights are burning, and we can see the people." No; we have learned that people may faint even when the lights burn well; and we never yet have heard of people dancing until the lights went out for want of air. No such foolish persons have, in all probability, ever existed. Still the work of the miner is nearly as hard as dancing, and he sometimes remains until the impurity has increased till it is thirty times greater than the amount of increase that is considered admissible in well-regulated houses.

Wet Clothes.—The miner is one of the few, if not the only man, who works in a warm and moist climate during the day, and comes at night to real winter in his wet clothes. The Commissioners recommend changing-houses at all mines; and Lord Kinnaird has given a model of one with every convenience.

It must not be supposed that every miner is wet, or that every mine is unprovided with a warm changing-house. We have met miners who preferred to work below because it was dry, and free from the cold winds and storms of the upper world, or "the grass," as they called it.

In some districts there is an actual dispute among men as to the advantages of the two worlds—the one below or the one above. Still the medical witnesses consider the moisture one of the greatest evils, and the cause of frequent rheumatism.

Heat—is not in proportion to the depth of a mine according to the agreement of all, but it is said to be greatest where there are sulphur compounds. The oxygen is in all probability admitted by the mining openings, and a slow combustion begun, if it did not exist previously, although to a small extent.

Mr. Edwin Chadwick said, twenty-one years ago, speaking of Dolcoath, one of the oldest and greatest mines—"Care is taken of the miners on quitting the mines; hence, instead of issuing on the bleak hillside, and receiving beer in a shed to prevent chill and exhaustion, they issue from their underground labour into a warm room, where well-dried clothes are ready for them, and warm water and even baths are supplied from the steam furnace; and, in the instance of this mine, a provision of hot beef-soup instead of beer is ready for them in another room.* The honour of having made this change is said to be due to the Right Honourable Lady Bassett, on the suggestion of Dr. Carlyon. "The ventilation is particularly good, and the men healthier than in most other mines."

Cornwall does not seem to be far advanced in the knowledge of sick clubs. Mr. Tidd Pratt has given a code of laws for them, appended to the Commissioners' Report. The Report recommends a system that would give help in sickness, as well as in cases of accident. With a population evidently disposed to carefulness, much is to be done by a good organization.

The Commissioners recommend that boys under fourteen years of age should not go down the mine.

Abandoned shafts have the care of the Commissioners; and certainly there are districts where the surface is covered with such pitfalls, which stand ready to hide unnumbered crimes.

Returning to the question of ventilation, the Commissioners are fully aware that there may be a diversity of plans used; they say—"In small mines, and in certain parts of large mines, a good supply of air may be provided by means of contrivances which cannot be economically supplied on a large scale, such as different descriptions of air-pumps, water-blasts, and fans."

The Commissioners recommend "the rarefaction of the air in one of the shafts by the heat of a furnace." "A system of Trunk ventilation being thus established, the pure air may be guided to any part of the mine," as in coal pits.

The ventilation is sometimes naturally very good, that is, the foul air goes up one shaft and fresh air down another; but this is not so in all mines, nor in every state of the weather. This cannot happen when there is only one shaft, or an insufficient communication by winzes, and a neglect in the guidance of the air. To these points the recommendations are directed.

The amount of air driven through coal pits is enormous; but in metal mines such an amount is not required, and smaller fires would be sufficient for the purpose. In coal pits the carbonic acid and carburetted hydrogen issuing from the coal, render great currents of air necessary, not merely for breathing, but for preventing explosions.

Among miners some, of course, are highly advanced, but according to the evidence given before the Commissioners, there are to be found men who work in dangerous places knowing the dangers; agents who refuse to supply air to the men, or delay it too long; men so

* The soup is not continued we believe.

ignorant that they imagine they may work safely if the candle burns even dimly. We have heard it said that they actually advance into places where the candle will not burn, leaving it behind. There are also men who pay 72*s.* for work which could be done in pure air at 45*s.*, but who still do not ventilate sufficiently; men who risk their lives, perhaps unwillingly, but because of their poverty. There are men who doubt whether any of the evils of mines come from bad air, although the whole history of the art presents to others one volume of proof that it is really so. By whatever method pure air is obtained, it is essential that it should be supplied: every miner agrees that the cure is possible. If we examine any other subject of complaint, the same conclusion is attained: a cure seems to exist for all. We find mentioned a remedy for the wet clothes, so often worn by the men on their way home—for the evils of unsheltered places where women and children take their meals—for the excessively long ladders—for the unbratticed shafts—for the unguarded sumps, winzes, and shoots—for the careless blasting—for the lax method of reporting the condition of the mine—for the bursting of boilers—for the inconvenient changing-houses—for abandoned shafts—for the too early entrance of boys underground, and for the want of sick clubs.* It may be added that pure air seems to promise a commercial advantage where a loss is much too common.

It would appear as if more than enough has been shown to prove that no time ought to be lost in devising a mode of encouraging those means of safety already known. If attention to the subject is fostered by Government, invention will introduce numberless facilities, whilst difficulties which are even now few will cease. In time, workmen and masters will be equally thankful for such attention, as it promises to increase the wealth of both, and render longer and happier the life of the whole mining community.

ON A PLURALITY OF WORLDS.

By WM. CARTER, M.B., B.Sc., Lond.

THE belief in the plurality of worlds, which has existed for the last three centuries, has been engendered by different circumstances, and held on very different grounds and with varying force accordingly. The revelations of Astronomy, by establishing certain general resemblances between the terrestrial globe and some of the heavenly bodies, and by proving the operation on all of these alike of physical influences, differing only in degree, were alone sufficient to cause many to receive it almost as a settled truth. Others have had their belief strengthened by the progress of Biology, which has shown that there is no spot so insignificant, and but few conditions so strange, as to be incompatible with life; that on bare granites, as well as rich alluvium,

* See the recommendations of the Commissioners.

in the fervid tropics, as well as in regions of almost perennial frost, in ocean depths so great as to be impervious to the faintest ray of light, and where the pressure of superincumbent water equals a ton-and-a-half on the square inch, as well as in the highest and most attenuated regions of the atmosphere attained to, living beings abound. While yet others, by adding to their knowledge of the present universality of life that of its equal extension during the measureless ages of the past, have had the conviction forced on them that it is always and everywhere co-existent with the conditions fitted for its maintenance. For Geology, leaving the fair face of the green Earth and proceeding step by step down towards her awful foundations, points out the evidences of many a world long since passed away, with physical conditions differing often from those which prevail now; while, at the same time, she lays open the silent tombs of innumerable and strange creatures, to whose organizations such conditions were most minutely adapted. And yet, after having descended into the regions of an immeasurable antiquity, she is obliged to confess her inability to reach the beginnings of life on the Earth, admitting that, for aught she can tell, as extensive an animal and vegetable series might have existed previous to, as since, those earliest traces which she has yet discovered. For every new revelation serves but to strengthen the probability that the entire series of rocks is passing through a ceaseless cycle of change, and that granite itself may be but the extreme term of a metamorphism, that by its intensity has obliterated all vestige of organisms with which it might once have abounded. Certain it is that the Histiodermas and Oldhamias of the Cambrian period have lately been proved to be recent compared with the incalculably more remote Polyzoa and Foraminifera brought to light in the lower rocks of the Laurentian series, which, in their turn, will probably be shown to be as far removed from organisms of an earlier period yet to be discovered.

Although, however, life is so widely diffused, it must be admitted that so far as we are cognizant of it, it cannot exist in the absence of certain conditions. Whether other forms, of which we know nothing, may do so, is an irrelevant inquiry.

The question to determine then is, whether such conditions exist on other planets: and to what is known of the physical constitution of these, we shall accordingly direct attention, passing by, as of too uncertain a nature for our present purpose, all speculations on Cosmogony, or on the probability of the sun's being a variable or a nebulous star or member of a binary system, &c. To begin with elementary constitution—this may fairly be concluded to be similar in all the members of the solar system, for since iron and many other elements are proved by spectrum-analysis to be present in the Sun, and by direct chemical processes to form part of those small bodies which as meteors occasionally strike against the Earth; and since there can be no possible reason why such elements should be found in these distinct members of the series, and yet be excluded from the rest, the only fair conclusion is, that they enter into the composition of Venus, Jupiter, and the other planets also. Moreover, the study of meteorites

has shown that olivines, augites, anorthites, and other minerals analogous to, though not strictly paralleled by, those of the earth, abound beyond its limits; while by a microscopic examination of the sections of these Mr. Sorby has further shown that they have excellent glass and gas cavities, like those present in lavas, proving that they once contained vapour, and were in a state of igneous fusion. A very intimate resemblance has thus been proved to exist between different bodies in the solar system; while by methods of research, available for the examination of the physical constitution of bodies beyond its limits, this resemblance has been found to extend in some respects to them also. For the spectroscope reveals the very suggestive fact that many of the fixed stars have at least a considerable proportion of similar chemical elements to those which abound in the Sun and Earth, and that the ones which are most extensively diffused, and of whose evidence the clearest indications are afforded, are such as are known to be most closely connected with the constitution of living organisms, —just those indeed, which, when influenced by heat, light, and chemical force (all of which are undoubtedly radiated from these stars), afford some of the most important conditions for the maintenance of life.* True it is that no undoubted organic remains have yet been discovered in any meteorite, or other body outside of the earth. Hydrocarbons were, however, present in the stones of Kaba Bokkereld, &c., and it is perhaps fairly open to question how far these may not indicate the operation of organic agency.† But a similarity in elementary constitution among the different members of our system, necessarily implies other conditions, which serves to bring still closer the likeness to one another. For so soon as a number of chemical elements are in a position to exercise their natural affinities, local forces of great intensity are developed, which inevitably give rise to irregularities of outline. The same is true of the simpler minerals which these elements by their union form, many of them assuming such different volumes under similar circumstances of temperature and pressure, as to be competent to the production of extensive fractures, elevations, and contortions in any mass of which they form a considerable proportion. Thus, while granites, syenites, and basalts diminish in density, though in very different degrees upon the application of heat, zircons, yellow obsidian, and others, augment. The variety of surface thus physically inevitable from the possession by the planets of a similar elementary constitution, explains and gives additional force to the interpretation of appearances visible through the telescope. If in addition to this superficial inequality, water can be shown to be present, there will be on other planets the elements of that ceaseless cycle of geological change which is so marked on our own, namely, attrition, disintegration, lamination, and stratification, causes which combine for the production of fertile soils. That this is present in abundance will be evident when we inquire more particularly into the physical constitu-

* 'Phil. Trans.' for 1864. "Huggins and Miller on Spectrum-Analysis of Fixed Stars."

† 'Proc. Roy. Inst.' and 'Trans. Brit. Assoc.' "A. S. Herschel, B.A., on Meteorites."

tion of each. Previously to this, however, it should be said, that much more is known of some than of others, proximity to the sun in the one case and distance from him in the other, rendering observations on the extreme members difficult and uncertain. But, without inquiring into the exact limits of fair analogy, it will be readily granted that where, in case of a strong presumption existing in favour of an adaptation productive of some degree of similarity throughout the members of a related series, such an adaptation can be clearly proved in respect of two or more, the presumption is immensely strengthened that it extends to all. With respect to Mars, however, the proofs for this are complete; and in the case of Jupiter and other planets, as much so as the difficulty of observation can render them.

Moreover, where actual experience cannot be obtained, the want of it is no argument against a given probability. It is quite conceivable, for instance, that the animals obtained by Torell, Milne-Edwards, Dr. Wallich, and Lieutenant Brooke, from the black depths of an almost fathomless sea, under a pressure which not long since was thought to be utterly incompatible with life, might, if endowed with reason, and arguing from their limited experience only, question the possibility of creatures organized like themselves existing in such widely different conditions as those of their own station on the one hand, and such as are supplied by shallow water and abundant sun-light on the other. And yet, we now know that such reasoning would be inconclusive, because in these opposite circumstances creatures with precisely similar organizations do live.

To come now to what is known concerning the physical constitution of different members of our system.— The Moon, from being nearest to us, is of course best known; the charts of Boer and Mädler, and more especially the beautiful photographs by Mr. De La Rue, and models and drawings by Mr. Nasmyth, having made the part that is turned towards the Earth familiar to most people. So far as our present means of judging extend, this part cannot be inhabited, because many circumstances prove it to be devoid of an atmosphere. The chief of these are the want of appreciable refraction, the sudden extinction of small stars by her limb, and the absence of any atmospheric lines whatever in the spectroscope; although by this latter method very small portions of her surface can be separately examined. Thus, Mr. Huggins and Dr. Miller were able to observe parts equal only to ·0000346 of the hemisphere, or about one-third the size of Tycho, a lunar mountain some 19,000 feet high. But this uninhabitability of the Moon, even if it could be shown to extend to her entire surface, so far from weakening the opinion that the primary planets are tenanted serves only to strengthen it, because just those respects in which they differ from her are the ones which are known to be essential to the maintenance of life, and, therefore, the existence of such differences renders more probable the existence of the ends to which they are known specially to minister. But from the uninhabitability of the proximate surface of the Moon, we are not warranted in concluding anything concerning the remote hemisphere, the physical conditions of which, with the exception of those of the small portions seen during her librations, are utterly unknown; and that it may possess the con-

ditions of habitability is by no means impossible, for Prof. Hansen, as a result of his inquiries into the causes of the secular variation of the Moon's mean motion, has arrived at the conclusion that her centre of gravity and the centre of her figure do not coincide, the former being so much farther from the Earth, as to give to the proximate hemisphere a bulging of twenty-nine miles over the remote one; so that it would not be impossible for a considerable quantity of water to be collected on this without there being evidence of it to us, something like a parallel to such a condition being found, says Sir John Herschel, in the immense preponderance of water in our own southern hemisphere.

On turning to the primary planets, we are met by positive evidence of a very remarkable character. Combined observations on the best known of these, namely Mars, and especially the recent ones of Mr. Phillips,* show clearly that the climatal variations "are comprised within nearly the same thermal limits as those of the Earth," rendering certain the operation of some adapting cause; inasmuch as the relative distances of the two from the sun being as 100 to 152, and the solar influence therefore as 231 to 100, without it, the planet's surface, instead of possessing the genial temperature which it does of 40° to 60°, should be fixed in perpetual frost. This conclusion as to climate is deduced from tracing the changes which take place with variation of season in certain white glittering masses in the neighbourhood of the poles. The existence of these was first pointed out by Maraldi, in 1716, and the phenomenon explained by Sir William Herschel as due to the alternate accumulation and melting of large quantities of snow during winter and summer respectively. All subsequent observations have served but to confirm this opinion. Thus, Lord Rosse watched the planet for several months in succession, and observed the following changes. On the 22nd of July, 1862, when his first observation was made, the South pole, which, owing to the high inclination of the axis, could at the time receive but little solar heat, was in winter, and surrounded by a large white patch, having a radius of at least 500 miles. In the course of three months, however, during which it had been brought more under the sun's influence, this was reduced to less than a half, and appeared only as a small glittering ellipse. What renders the analogy with the Earth even more striking is, that in the same seasons of different Martial years, the amount of snow appears nearly equal; that it in no case is regular in its limits, but is collected along one or two principal tracts as far as 40° or 45° from the pole; and that it is invariably very excentric round the Southern pole, the amount of excentricity amounting, according to Secchi, to 17° 42′. The only probable explanation of these latter phenomena being the production of local elevations and depressions of temperature by the relative distribution of land and water, the constant set of warm aërial or oceanic currents, and so on, which we know cause the most marked inequality in any of the isothermal lines in our own Northern hemisphere. Local patches, similar to those about the poles, have at different times been seen in other parts, though of far less extent. The geographical limit of the isothermal, 32°, has been shown by Mr. Phillips to be

* 'Phil. Proc.' vol. xii. p. 431 *et seq.*; and No. 71.

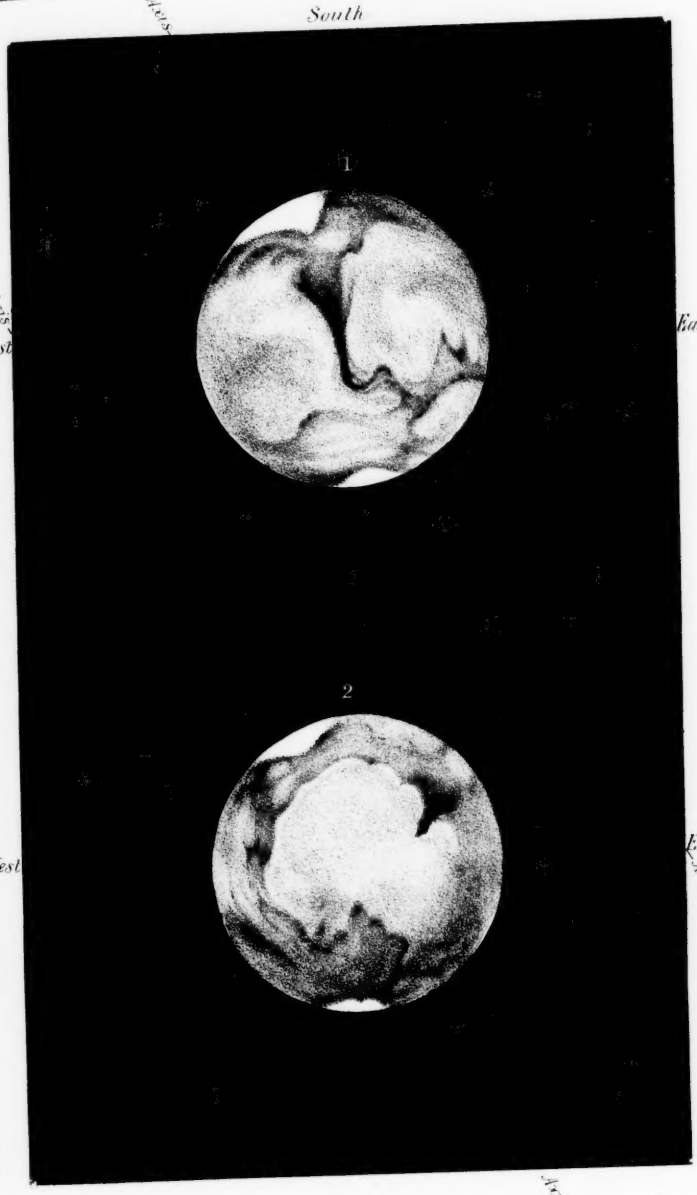
very little different from what it is on our Northern hemisphere, extending according to local peculiarities, such as those presented by the elevated table-land of Northern Asia in this case so low as from 40° to 60°, while on Mars the farthest limit yet known to be reached is 50°; the mean summer temperature of which, supposing the pressure to be the same as on the Earth, cannot therefore be less than 32° Fahr., and in many parts must be very much above it. Fifty is nearly the latitude of London; the mean annual temperature of which is 46°·9 Fahr.; but supposing the Earth were moving in the orbit of Mars, with only her present atmosphere, this temperature would be reduced in consequence of diminished solar influence to 2°·03 Fahr. Obviously, then, there must be some great modifying causes at work to counteract the effect of the planet's increased distance from the sun. What these most probably are, we shall consider when we come to an examination of Jupiter. For the present, we will only remind the reader of Professor Tyndall's experiments, showing that the effect of the distribution of aqueous vapours through an atmosphere is to prevent the dissipation of thermic rays into space, and to envelop the surface around which it lies in a warm mantle. Besides the evidence afforded of a Martial atmosphere by the phenomena described, independent proofs have been obtained by spectroscopic examination, so many strong lines being seen in the extreme end of the red, and such well-marked bands at the opposite part of the spectrum, as to render it certain that the atmosphere is of considerable depth.

The other superficial features of the planet are so striking, that drawings made by Mr. De la Rue, and the late Captain Jacob, of Madras, were referred to a Committee of the Royal Astronomical Society, with the view of mapping it out. Two of these, by the former gentleman, form a part of our illustration, and are peculiarly interesting, inasmuch as they exhibit Mars under the two different aspects, consequent on the axial rotation during an interval of two hours. In India, where atmospheric conditions are very favourable for observation, his aspect is exceedingly beautiful, and begets the inevitable conviction of his being, as described by Mr. Grant, "a perfect little world, with continents and seas like ours." In the drawings of Captain Jacob, representations are given of what appeared to him a chain of lakes near the South pole, similar to, though larger than, those of North America; and to all observers there is a marked difference of hue on different parts of the surface—some (the land) appearing red, while others (the seas) look greenish. There is also indication in the occurrence of temporary fogginess of detail of considerable atmospheric vicissitudes.

On considering the physical constitution of Mars, can we conceive of anything in it incompatible with life? On the contrary, does not the presence of the precise conditions, which we know to be adapted to its maintenance, afford us the best evidence for believing in its manifestation?

The position of Venus with respect to the sun is such, that even in the improbable absence of a system of compensation of the opposite tendency to the one which operates on Mars, there would be nothing in it to render her uninhabitable, the mean quantity of light and heat

Axis
West
West



Warren De la Rue, del. Haviart, lith. Edwin M. Williams, Phila.

MARS.

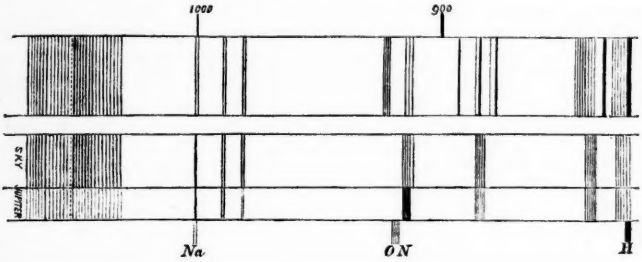
N°1. APRIL 20th 1856 8hrs 40min GMT. N°2. APRIL 20th 1856 11hrs 45min GMT.

on her surface even then not being quite twice that on the Earth's, Owing, however, to the high inclination of her axis, her equator being inclined to the ecliptic at an angle of 28°·42′, the direct impingement of solar rays on any given part continues but for a very short time, so that during her short year of 225 days, two winters and two summers are experienced in nearly every latitude; similar to that which occurs, though in a less marked degree, within the terrestrial tropics. The same extreme inclination throws her tropics into the polar regions, and renders the equator the coolest part of her surface. The indications of an atmosphere are very decisive, but the difficulty of observing her surface is so great as to require the exercise of much caution before accepting statements that have been made concerning the heights of mountains. During the transit of 1761 and 1769, she was observed by several to be surrounded by a faint ring of light, caused probably by the passage of solar rays through a circumambient fluid; and the extension of a crepuscular light along her unenlightened cusps first noticed by Schröeter, indicates the same. As the mean of seven observations on the measure of its diffusion, Mädler has come to the conclusion that the horizontal refraction equals 43′7″, which is $\frac{1}{6}$ greater than that of our atmosphere—an amount larger than that calculated by Schröeter. If we yield ourselves to the inferences flowing from a consideration of such facts as are known concerning Venus, and still more if we take into consideration the operation of some undemonstrable system of compensation which the case of Mars renders so probable, we can hardly conceive, as entirely void of life, a planet so admirably adapted to its maintenance, and so fully supplied with materials capable of organization by vital forces.

Before considering the physical state of the other planets, it will be well to glance at some of the chief circumstances which are known to modify temperature. That the degree of warmth does not wholly depend on the quantity of heat radiated from the sun, is evident from the extreme want of parallelism of any isothermal line with the equator, as well as from the undoubted indications that exist of the comparatively elevated temperature of Palæozoic times. For as there does not seem sufficient reason for thinking that the equator has ever varied in its inclination to the ecliptic beyond 1° 21′—the limits assigned by La Place—the extraordinary fact of tropical animals and plants having flourished in regions between 78° and 80° N. lat. seems inexplicable, unless some modification, probably atmospheric, were in operation to render more efficacious than at present the amount of solar heat given to the Earth, supposing of course that the radiation was not more intense then than now. The relative distribution of land and water, diminished elevation of land, the action of warm aërial and oceanic currents, or indeed modifications of any existing agencies however powerful, even if it could be rendered probable that they existed, would seem scarcely competent to the production of so general a climatic change as is implied by the facts mentioned. There are causes, however, amply equal to their production, and some of which at least can be shown with great probability to be in action on other planets. One of these is the difference in absorbent capacity of

various atmospheric and other gases; Prof. Tyndall having shown that while oxygen, nitrogen, and some others, are, like rock-salt, absolutely diathermic, and dry air nearly so, carbonic acid, marsh, and olefiant gases, when compared with the latter as 1, possess absorptive powers of 90, 403, and 970 respectively. Obviously, therefore, the diffusion through the atmosphere of a considerable quantity of either of these gases, which unlike aqueous vapour are incapable of being deposited in a condensed state, would by preventing the dissipation of heat by radiation, keep up a high degree of general warmth. Some such condition of atmosphere may have existed previous to, and during, the Carboniferous period. Another cause, and one on which, from the proof that is obtainable of its operation on other planets, greater stress must be laid, is varying depths of atmosphere. Although the evaluation of the intensity of this has been recently shown to be rather less definite than was supposed, it is still sufficiently so to be made the basis of very important conclusions. The most general fact noticed by all scientific aëronauts, from Gay-Lussac to Glaisher, is that there is a very marked diminution of temperature with ascent into the higher regions of the atmosphere. The theoretical value usually assigned to the decrement is 1° for every 300 ft., and this was the actual value found by Mr. Welsh, in 1822. Mr. Glaisher has come to the conclusion that this result is generally true up to a height of 5,000 ft., when the sky is partially cloudy, the diminution, however, even within these limits, being in a greater ratio in the lower than in the higher strata. Above 5,000 ft. he found the decrement reduced to 1° in every 1,000 ft. Gay-Lussac, who ascended nearly 23,000 ft., found the temperature reduced from 82° on the surface to 15°. Mr. Hopkins, of Cambridge, has applied these data to determine the question of how far different atmospheric depths alone would affect the temperature of different planetary surfaces. According to the ordinary law of radiation the amount of heat and light at Jupiter would be as 1 : 27 compared with that at the Earth. If our planet, therefore, were moving in Jupiter's orbit with her present physical arrangements, the mean annual temperature of her equator would be—34°·42 Fahr. (—36°·9 C.), and at the pole a little more than —39°·1 Fahr. (—39°·5 C.), and 35,000 or 40,000 ft. of our basic atmosphere would elevate the equatorial heat to an equality with that of our present temperate zones. At the other planets a proportionate addition or subtraction would be attended with proportionate effects. To inquire now into the physical arrangements on Jupiter; telescopic observations prove that the light from him is mostly reflected from cloud-like masses above his surface, the intensity of the whiteness of this light exceeding that reflected from any known opaque substance, and being far greater than that thrown off from an equal area of new fallen snow, and fourteen times greater from any given space than that from an equal surface on the full moon. If these masses should be proved to be clouds they would afford unmistakable evidence of an atmosphere, though the depth would still remain unsettled. On both these points, however, there is very satisfactory evidence. For, from the fact that the dark lines in the solar spectrum increase as the sun's altitude

lessens, and his rays consequently traverse greater lengths of atmosphere, an element has been obtained which serves as a standard whereby to judge of the existence of atmospheres around other planets. Many observers have decisively settled this point with regard to Jupiter, Saturn, and other members of the solar system. For, by comparing the spectra of the Moon and Jupiter when at the same altitude, and when therefore the light reflected from them was under precisely similar atmospheric conditions, bands were present in the former which were not found in the latter, and which were due therefore to some modification before reaching our atmosphere.



The drawing which, through the kindness of Mr. Huggins, we are able to give, demonstrates this even more satisfactorily, for, in the observation of which it is the result, the spectrum of Jupiter was seen in direct contact with that of the sky, and the lines in both were seen to be exactly coincident. The comparison in this case was rendered possible by the slit in the spectroscope being greater than the telescopic image of the planet, and by there being just enough light left after the sun had gone down to form a visible spectrum of the sky, which therefore was directly superposed on that of Jupiter. Though co-incident in position the lines will be seen to vary somewhat in intensity, those at 882 and 833 being less intense in Jupiter's spectrum, while those at 914 are stronger. The coincidence probably shows, as Mr. Huggins and Dr. Miller remark, that the planet's atmosphere, with respect to some of its elements at least, is similar to ours. Other lines were present, but were too faint to be represented. Many more, however, have been given by Father Secchi, some of which have no representatives among lines due to our atmosphere, while one of those most closely coincident is always found to prevail during foggy weather.

But the vapours which produce these atmospheric lines in the solar spectrum are principally found in the lower and denser parts of the terrestrial atmosphere, while the parts corresponding to these on Jupiter are not traversed by the light, forming his spectrum, which, as before observed, is reflected from cloud-like masses above the surface. Therefore if there is an atmosphere dense enough to give such well-marked lines *above* these clouds (as we shall show them to be),

that beneath them must be much denser; still, the whole much deeper than ours. The effect of such an arrangement in elevating the general temperature has been already pointed out. The position, form, and movements of the planet's clouds were admirably seen by Prof. C. P. Smyth, under the fine atmospheric conditions afforded by an elevation of 11,000 ft. on the Peak of Teneriffe. "There," he remarks, "the mere streaky bands which cross his disc become resolved in the telescope under high powers into regions of cloud. The brighter spaces were the clouds, and their forms were as characteristically marked and were drifting along as evidently under the influence of a rotation wind as the cumuli and cumulo-strati, which the terrestrial N.E. current was at that moment bringing past Teneriffe under our feet—while in addition there were minute changes in the relative positions and forms of the vaporous masses in either hemisphere, indicating as well the presence of wind as the ephemeral nature of mist. Far more striking, however, was the testimony borne by the more constant form of the clouds seen best towards the equatorial parts of the planets. At this tract one could not gaze long without acquiring the impression of looking at a windy sky; the whole zone of vapour seemed to be in motion, while from its ragged edge portions were torn off and were driving along, some of them rolling over and over, and others pulled out in length."

A better description of a clouded terrestrial sky could scarcely be given. One very suggestive feature was noticed clearly by Prof. Smyth, namely, that the comparative calmness in the equatorial region which has been so often observed, and which as he remarked seemed more inclined to strati and cirro-strati than to the tempestuous cumuli of the tropics, was not exactly coincident with the equator. This is also evident in the beautiful drawing of Jupiter, by Mr. De la Rue, which forms one of the illustrations to this paper, and "seems to require the operation of some such cause as makes the southern trades overbalance the northern ones on the Earth, and throw the zone of equatorial calm into northern latitudes, namely, the unequal distribution of land and sea surface in the two hemispheres." Besides the appearances above described, which are the ordinary ones, there are others at times indicating greater periodical changes, such as large black tracts, numerous glistening spots, &c.

In the conditions of Jupiter thus far ascertained, in many respects so analogous to those which prevail on the Earth, none appear which are inimical to life—none, indeed, wider than are known to embrace it within their limits. The increased weight of bodies on his surface, owing to his greater attraction, when subjected to the reductions due to his larger radius, less specific gravity, and increased centrifugal force (which last is sixty-three times as great as the Earth's), would be less than two-and-a-half times what it is on our planet, a difference scarcely without parallel in cases of living animals possessing nearly equal muscular power.

The very small angle of 1° 18′ 52″ which the planet's orbit makes with the ecliptic, combines with his dense and vaporous atmosphere to produce a considerable equality of climate on all parts of the surface.

The quantity of solar light at the outside of the Jovian atmosphere, though but in the proportion of 1 to 27 of that immediately outside of ours, would yet, even after allowing for great diminution before reaching the surface, be much more than is required by many terrestrial animals and plants. The reflection from his four moons, too, must at least make some small compensation, if any deficiency of direct solar light exist. Of this, however, there is no certainty, because the amount which reaches the planet itself depends on the absorptive and other qualities of the media through which the rays pass to it—qualities which differ entirely in their effects on rays of different periods of vibration. Both of these truths are well shown in the Earth's case, as by far the larger portion of solar rays is absorbed before its surface is reached, but in different proportion, according to their refrangibility and to the prevalence of certain atmospheric constituents; aqueous vapour and carbonic acid gas, for instance, being almost completely diactinic, *i.e.* penetrable by the more refrangible rays, while they hinder the passage of thermic ones.* And very recently it has been even proved that, under special circumstances, substances may absorb non-visual rays and give them out again transmuted into visual ones.† Still, as no modification of any of the kinds indicated can be proved to exist; that the planet's atmosphere does differ in absorptive capacity in some way, is all that can at present be said, this difference being clearly indicated by the spectroscope. Of the planets beyond Saturn very little is known; but if we can see indications of a specific adaptation up to the extreme point cognizable, it is fair to presume that it extends further and involves the entire series. These indications are not wanting with respect to Saturn. He has belts which are sometimes almost as distinct as those on Jupiter, and obviously arise from a similar cause, namely, the combination of some external influence with the planet's rotation. There are, moreover, independent proofs of an atmosphere by the spectroscope. The most wonderful feature connected with him, however, is his system of rings, which, says Sir J. Herschel, "must present a magnificent spectacle, as vast arches spanning the sky from horizon to horizon," to the inhabitants, if there be any. How far they, with the eight satellites, make up by their reflection for any diminution of direct solar light cannot be said; but that they possess great, though not uniform reflective power, observations prove. A striking analogy has been remarked to Mars in the presence of a space around each pole, which varies in extent and brilliancy according to the seasons of Saturn's long year. Whether this results from the formation and melting of snow, or the accumulation of clouds, it would seem equally to indicate a variable atmospheric influence.

In many respects all the exterior planets resemble each other. They are all large, of low specific gravity, accompanied by more than one satellite, and have a nearly equal revolution, and but small inclination and orbital excentricity; so that, except as they are differently

* Dr. Miller in 'Journ. Chem. Soc.'
† 'Phil. Mag.' No. 192. 'Phil. Proc.' No. 71.

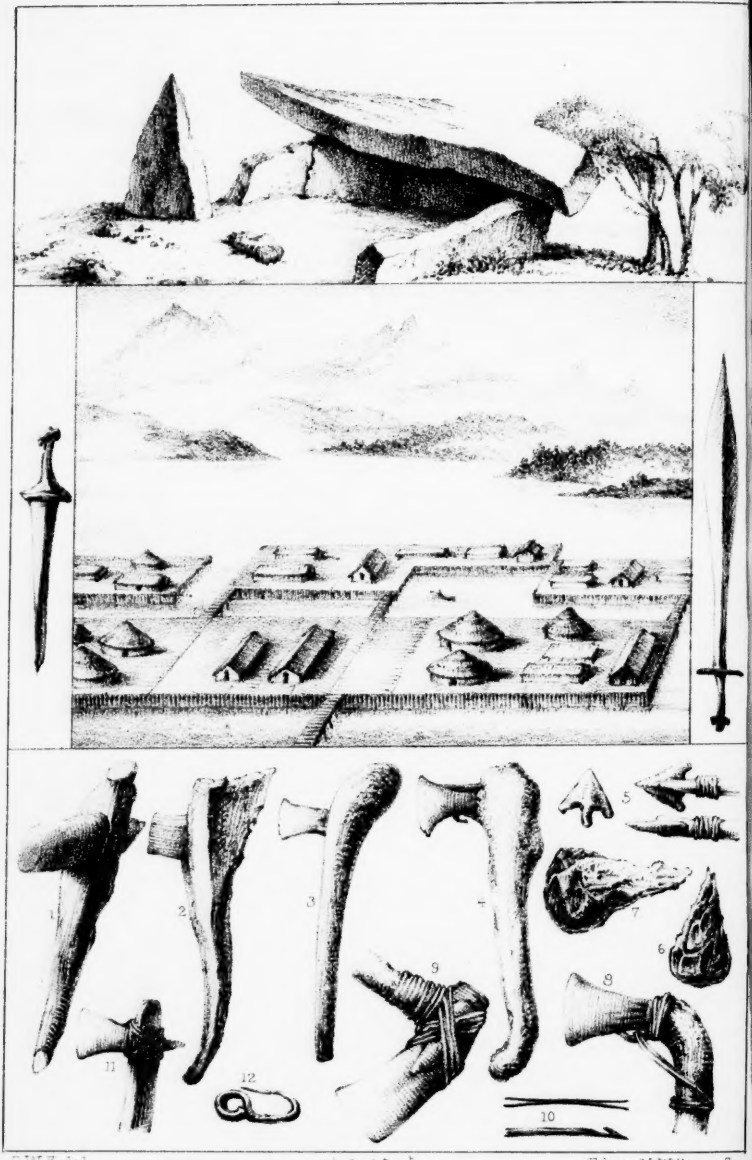
affected by their different distances from the sun, any conclusion arrived at concerning one of them would be equally applicable to the rest. With respect to heat, there seems clear evidence of a compensation for diminished solar radiation. The same cannot, however, as yet be certainly said of light. But even on the ordinary law of radiation, and not considering the small but appreciable effect from the four, if not more, moons of Uranus, and the two of Neptune, the amount of light at the distance of the latter must be far beyond the limits enjoyed by many terrestrial creatures. The light from brightest sunshine has been calculated by Wollaston to be equal at the Earth to 805,072 full moons, and as Neptune is thirty times more distant than it from the sun, he would receive $\frac{1}{900}$th the amount, or an equivalent to that of 890 full moons, if his atmosphere exerted the same absorptive effect as ours. The average day of the exterior planets is ten hours, their years varying in length from nearly 12 of ours on Jupiter to 164¾ on Neptune. The specific gravity, compared with that of the Earth, varies from ·24 for Jupiter to ·14 for Saturn.

Between Mars and Jupiter are from 75 to 80 small planets, of which more is unknown than known. We will merely observe that their aggregate mass is much smaller than their number would seem to imply, as Le Verrier concludes, from its producing no perceptible variation in the heliocentric longitude of the perihelion of Mars that it cannot equal one-third that of the Earth.*

On summing up this subject we find that on our own planet every element, every region, and nearly every foot of space swarms with living creatures possessing an endless diversity of organization to suit an endless variety of condition; that throughout all geologic ages "the systems of life have been varied from time to time, but never extinguished;" that from microscopic creatures only the millionth of an inch to the immense Dinotherium giganteum, or the Megalosaurus, seventy feet long, there has been every gradation of size; that beyond our planet there are evidences of adaptation, first on one and then on another member of the series to which it belongs, of a character such as to render them probably habitable; that, furthermore, there are indications of a great number of such series in the existence of bodies resembling the sun as independent sources of light, heat, and chemical and attractive power, and, like him, abounding in elements which, under the influence of these forces, seem specially susceptible of ministering to the organization of living creatures; that many of these greatly surpass our own sun in some of these qualities, their light being so intense as to penetrate to the base of our atmosphere, while themselves are often so distant as to afford no sensible parallax; that one of them at least is ascertainably of a much greater mass;† and, lastly, that their great distances from him and from one another would be explicable on the supposition that they had secondary systems revolving round them, which these distances preserved from destruc-

* 'Month. Not. Astro. Soc. for 1853 to 1855,' p. 63.

† The binary system, 70 Ophiuchi, is said by Sir J. Herschel on the authority of M. Krüger to be $3\frac{1}{10}$ times the mass of the Sun.



D.W.K. del. Hanhart Imp. Edwin M. Williams Sc.

ILLUSTRATIONS OF THE STONE & BRONZE AGES.

tive perturbation. And in the face of all this it seems to require a great strain, from the effect of which the mind instantly recovers when the force is removed, to think that throughout all space life can be absolutely limited to one small globe.

PREHISTORIC RECORDS.

By the Rev. C. W. KETT, M.A.

IN order to arrive at a knowledge of the condition of men in the early period to which we refer under the term Prehistoric, we have two sources of information — the one consisting of the *relics* of their arms, ornaments, utensils, habitations, and burying-places, raw materials, manufactures, and even bones, especially skulls, found in various places, in Kitchen-middens, Lake-dwellings, Burial-kists, and Barrows or Tumuli; the other being the traces in *language* of inventions, arts, pursuits, or possessions, which a diligent comparison of connected families of tongues leaves as a common residuum, and which, added to the comparison of mythology and law, go to make up the subject-matter of the now extensive science of Comparative Philology. Comparative Philology and Archæology, therefore, form the basis of the following paper.

The Prehistoric Age consisted of many periods of various, and, at present, of unknown duration. The principal of these may be arranged in the following manner:—The *Aryan Age*, when almost all the nations which are now settled over the broad face of Europe, in India, and through a large portion of the intervening tracts, formed one family, and dwelt in one small region somewhere between the Caspian Sea and the Himalayas: the *Age of the Dispersion*, which lasted whilst the scattered tribes roamed about the world in search of the habitations where they have since dwelt; the *Age of Stone*, when some early wanderers from the outskirts of the main portion of the nation having lost in their nomad life many of the arts which they possessed in the cradle-land of their race, or, more probably, some distinct race pushed forward by the advancing tribes of the Aryans, settled down in habitations somewhat fixed, employing the rudest and roughest of all materials—stone, for the production of nearly all their weapons, and even their domestic utensils; the *Age of Bronze*, when the metallurgic arts revived or were discovered anew, or perhaps even introduced by a new race, and an era of greater elegance and refinement once more broke upon the benighted intellects of the early inhabitants of this and neighbouring countries; and, lastly, the *Age of Iron*, which runs into the period of which we have some documentary account.

I must here guard against an ambiguity in the word *age*. By this is scarcely intended so much a fixed period of time, as a condition through which a nation has passed. Most of the nations of Europe, and probably of the whole world, have traversed these five stages,

XUM

but as the History of the Jews begins at a much earlier date than the History of Rome, and the History of England succeeds after a lapse of some hundreds of years, so it is scarcely possible to say that a Prehistoric Age of the Jews ever existed, whilst that of the South and of the North of Europe, of the Roman and the Teuton, extended to very different dates in the world's history. Other ages, too, besides those mentioned above will be referred to, such as the age of a particular kind of dwelling or mode of life, or, it may be, of a peculiar character of Flora in certain countries; we shall have to speak of the periods of the Lake-Dwellings, the Kitchen-middens, the Fir, the Oak, and the Beech; but these are neither co-extensive with the former, nor can they altogether be separated from them. With regard to these latter, we may say at once that Sir Charles Lyell,* on the authority of the Danish antiquaries, makes the Stone Age extend throughout that of the Scotch Fir (Pinus sylvestris) into that of the Oak, with which that of the Alder Birch (Betula verrucosa) flourished. The Bronze Age takes the remainder of the Oak, whilst the Iron corresponds nearly with that of the Birch. Again, some of these different ages may be contemporaneous — a Bronze Age in Britain might have existed at the same time as an Iron Age in Italy,† and probably an early Stone Age lasted in Britain whilst the Aryans still remained in their Asiatic home.

It would be impossible, in the space allotted to the present article, to give anything like a full account of the mode of procedure by which comparative philologists have arrived at a tolerably sure knowledge of the condition of the Aryan‡ race before it was dispersed over India and Europe. Comparative Philology reveals to us much concerning our ancestors. When we find words evidently common to all the nations descended from our forefathers, we can safely predicate that the idea represented by that word was known before the Dispersion.

Thus, if we observe that the Roman languages all contain similar names for many inventions and appliances of civilized life, we might deduce, even if we did not know it from other sources, that the Romans were acquainted with these inventions, and the elements of the appliances. In a similar way, many facts concerning the common ancestors of the Scandinavian and Hindoo may be deduced from the number of words possessed in common by their descendants. In the same way, the particular characters of any class of words will give us a clue to the history of a nation. If, for instance, the words referring to a particular branch of art or manufacture have all a foreign origin,

* 'Antiquity of Man,' chap. i and ii.

† A Roman historian (Polybius, I believe) speaks of the Gauls, in a battle during one of their early raids in Italy, straightening their swords by treading on them after a blow.

‡ The word Aryan has now been generally adopted to signify the race to which F. Schegel, in the early dawn of this science, gave the name of Indo-Germanic, which was afterwards extended to Indo-European. Erin and Iran, the native names respectively of Ireland and Persia, contain the root of this word Aryan, which is said to signify noble, and which is connected with that widely-diffused root AR to plough, from which we get the verb and the words ear, earth, arable, oar, &c., &c.

we may well deduce that art or manufacture was imported from the people whose words have been adopted to convey the idea represented. Several instances of this may be noticed, both known historically to have actually taken place, and also plainly deducible without such historical data.*

As in the languages of which we know the history we can confirm our knowledge by the testimony of words, so a comparison of the language, mythology, and law of the nations of the Indo-European or Aryan race has brought us conclusive evidence of which we may be sure that the general outline is true, though we may not be able to fill in the picture so thoroughly as we should wish. We find that at a time when this ancient nation dwelt in its first abiding-place, it was divided into divers tribes speaking various dialects; that it was first of all separated into two main streams—a northern and a southern; that as time went on, some overwhelming necessity, probably that which ever had and still has such an influence on the migrations of men —the desire of food — drove these tribes forward in various directions and at various times, now side by side, now chasing one another, like waves on the ocean—at one time parted by some insuperable obstacle, and anon reuniting with the clash of contending force, and then together again sweeping forward with increased energy over all barriers placed to oppose it.

But we want to see these nations as they once dwelt in their cradle-land.† Essentially pastoral, they differed at first but little from that other great race the Semitic, whose greatest leader had already passed westward over the river Euphrates. But, unlike him and his descendants for many generations, they were not nomadic. They dwelt not in the black tents of the Arab Sheik, Abraham the Hebrew, the Passer-over; but like him they possessed their flocks and herds, their sheep and goats, their oxen and horses,‡ their dogs, pigs, geese, and fowls.§ Their cattle, their chief wealth and sole standard of

* In this way the English names of many ecclesiastical services, garments, titles, &c., are of such Latin origin (or in some cases, Latinized-Greek form), that we cannot but remember that we owe our Christianity chiefly to St. Augustine and his Roman monks. Again, our military terms, as far as the words are ancient (many of the modern introductions are Italian or French, the former pointing to the bands of Italian mercenaries that overran Europe in the Middle Ages, the latter to our wars with France) are mostly derived from the Norman French. Our naval terms are of Scandinavian origin, whilst the terms of peaceful and agricultural employments are mostly Anglo-Saxon. In Latin we see something similar in the fact that most agricultural terms are nearly allied to the Greek, whilst the derivations of the military terms are harder to trace, pointing to the fact, probably, that the ancestors of the Romans were descended from two tribes, the conquering and dominant one not being so closely allied to the Hellenes, as the conquered and industrious class.

† The results given in these sections are principally taken from L. F. A. Maury's 'Histoire des Religions de la Grèce Antique,' Mommsen's 'History of Rome,' and A. Pictet's 'Les Aryas Primitifs.'

‡ The Jews were forbidden to use horses, and seem to have had none until Solomon's reign. The Arabs, too, are represented on the Nineveh sculptures as riding only on camels.

§ Geoffroi St. Hilaire says that there are forty species of domesticated animals, of these thirty-five are to be found in Europe, of which again thirty-one have

value (pecunia and fee), roamed not from pasture to pasture, but were protected by stables and enclosures. The rites of hospitality required the fatted calf for the stranger. The vine* had flourished since the days of Noah. On the daughters† of the tribe devolved the duty of milking and churning; and the products of their industry with flesh of the flock, which they could season with salt, formed the staple food of all classes, though barley, and perhaps other kinds of corn, and some vegetables, were not unknown. A little later, when the North parted from the South,‡ the plough was introduced, the oxen were yoked to it, and agriculture began to advance. The life was no longer exclusively pastoral; they sowed different sorts of grain, cultivated vegetables, planted the vine, pressed the olive in order to extract the oil: hence instruments had to be made, trades arose, a division of labour was begun. The carpenter had his knife, hatchet, auger, hammer, perhaps even a saw, but we know not of what material—stone, bronze, or iron. The distinction between these latter metals is not clear, but they possessed others—gold, silver, and tin, from all of which objects of finery were fashioned. Bronze was hardened by hammering and tempering; it was sharpened; and arms formed of it could be furbished; in working it the forge with bellows, pincers, hammer, anvil, were put in requisition.

By their knowledge of corn, as an edible product, they esteemed themselves advanced in civilization far above the barbarians, who, they supposed, existed on acorns and beech-nuts. Spinning and weaving wool and hemp and flax, were practised; needles and thread were not unknown. The art of the potter was developed in many directions, and his productions took their place beside the articles of wood and stone in the dwellings of these shepherds.

They did not dwell in tents like Arabs, nor in waggons like Scythians, but how their dwellings were constructed we know not; though that they were not the mere huts of savages, we may judge from the fact that they knew of doors, openings for windows, domestic hearths, and separate chambers for sleeping. These dwellings with their stables and enclosures, generally it is supposed stood alone, but villages, and even small towns encircled by a wall, were occasionally to be found. What the ordinary dress of that period might be we cannot tell, but we may well suppose that the golden finger-rings, torcs, bracelets, and neck-rings of a later time, were preserved from these early days, being less destructible than many more useful articles, and taking considerable time to acquire in the numbers,

their original habitat either in Central Asia, the Eastern coast of Africa, or on the shores of the Mediterranean in Southern Europe.

* The Hebrew word for wine יַיִן is closely allied to the Aryan-root of *Γοίνος*, vinum, wine. Sans. vêna beloved, used in the Vedas for the ambrosial Sama. As yet no philosophic attempt has been made to compare the Semitic with the Aryan roots.

† Daughter, Sans. duhitar, the milkmaid. See M. Müller, in 'Oxford Essays, 1856.'

‡ The words now have their roots only in Sanscrit, the entire words are common to the northern nations of the Aryan family alone.

and with the amount of elaborate ornamentation that we find at a later date.

The sole wealth of this pastoral people consisted of cattle and slaves, with the few simple utensils referred to above; raids, we may well imagine, were not more uncommon than we find them at later periods, and accordingly we find that military terms are widely diffused. The warrior was armed with the lance, the javelin, the bow-and-arrow, sword, mace, battle-axe, perhaps the sling. He defended himself with a shield, but we cannot trace other defensive armour. Horses were yoked to chariots, but do not seem to have been used for riding. In fact, riding was an accomplishment acquired about the time of the early settlements in Europe, but shortly before we come to some trace of actual history. Instruments of music gave signals of war and encouraged the combatants. Little, probably, was known of navigation before the arrival of the nations at the Caspian, or even at the Black Sea or Hellespont.

Family ties were recognized and respected in this early condition of our race. The ceremonials common at marriage-festivals prove the importance attached to that event. Brothers, sisters, uncles, aunts, nephews, nieces, son-in-law, daughter-in-law, brother-in-law, and sister-in-law, each had their names and their position. Families increased into clans, and clans into tribes. The father developed into the chieftain; the chieftain into the war leader,—the king; and the heads of families into elders and senators; but the rights of the younger men, freemen and not slaves, were respected. Territorial possessions were fixed and bounded, property descended by inheritance; buying, selling, and exchange, were resorted to. Nor had life only a serious aspect. Besides the amusements of the chase, these early peoples cultivated music, dancing, poetry. The reed-flute and a stringed instrument were added to their martial music. Dice, and possibly some game like draughts, were the pastimes of the chiefs.

Of their religious feelings it is more difficult to speak. They seem to have recognized the soul as something to be distinguished from the mere breath of life. They had terms to express knowledge, will, memory, thought, and these abstract words were removed from their original concrete signification. It is clear that all abstract terms are derivable from sensuous ideas, but this step of derivation was made by the early Aryans. In their early realization of the abstract, no nation approached this race so early destined to be vigorous in philosophic culture and penetration.

A decimal system of notation, founded probably, as amongst most other races, on numeration by the fingers, was current before the Dispersion. The year consisted of 360 days, and was divided by the revolutions of the moon. The Great Bear* had received its name, though planets were not as yet distinguished from fixed stars. By the Milky Way souls were conducted to the sky. A tradition of a deluge that destroyed the human race was handed down, but their religion had become a polytheism, a worshipping of the powers of nature per-

* Max Müller's 'Lectures on the Science of Language,' 2nd series, p. 361.

sonified, still with a grand underlying belief in* one controlling Deity, God of gods and Lord of lords.

Such were the Aryans, as far as we can picture them to ourselves from the remains of their language. In such a sketch as this, however, we must guard ourselves against two sources of error: the one, that the absence of words representing ideas necessarily implies the absence of the idea; the other, that the presence of the same word in distinct branches necessarily implies the knowledge of the thing represented in the race before these branches were separated. In the former case it must happen occasionally that amid the phonetic attrition of ages, sounds have altered or become obsolete, so that but one tongue has retained any trace of the original denomination. Besides we have every reason to believe that in ancient tongues there were many words distinguished by shades of meaning no longer recognized, as in the case of the list of terms to designate the carving of various birds and animals as given by Lady Juliana Berners, most of which terms, though in use in the Fifteenth Century, have now become extinct. In various dialects one of these expressions might be used to designate the whole; in another, another. We should, in both these cases, have no basis for comparison, and though we could not be sure that the idea existed, we should have no right to say that it had not existed. On the other hand, where the word does occur in different languages we must ever guard against the possible introduction of the word into the one language from the other. Thus, in the Keltic and English (both Anglo-Saxon and Romance) there are many words which ardent Keltic scholars would fain claim as the inheritance of their favourite race, bestowed by them upon the intruders on their land, whilst Teutonic philologers, disdaining the elder race, sweep all into their own net. Too substantial a fabric, then, must not be built upon such doubtful foundations until we spread a wider surface to support the superincumbent mass. Here Archæology comes in, and together with tradition, scraps of History, and other relics of a forgotten world, helps us to shore up a tolerably substantial framework under which to collect, arrange, and turn to account the knowledge we may glean from all these quarters.

Of the Age of the Dispersion we know at present scarcely anything. A scattering of the nations must have taken place, because they were once united, and we now find them separated. We may imagine that hunger, the love of adventure, or the curse of Babel, drove them forth. Too narrow a country, a desire to see what was beyond their own happy valley, disagreement and misunderstanding with their neighbours, are all motive powers, potent in those days as they have been since. At some future stage in the history of science, it may be possible to trace to a certain extent their wanderings, now entirely shut out from our ken. All we know as yet is, that the ancestors of Greek and Roman remained united after they had broken off from the original stock; that the Keltic wave preceded the Teutonic over Gaul, Britain, portions of Spain, and Italy, whence it sent forth

* Max Müller's 'Lectures,' 2nd series, lect. 10.

armies to conquer Italy, Greece, and even Asia Minor; that the Teutonic, both Low and High German, traversed some portion of the road in common with the Scandinavian; that they then parted to meet at a future period, and to make this island their battle-field. Comparative Philology, one of the newest of the sciences, has told us much of an older age. Archæology, a very old study, has only of late revealed much that is new to us about a later period, perhaps some new science yet to be discovered, or at all events perfected, will tell us more of this transition state.

We must now leave for a time the Aryans as we have found them amidst the diversified country of West Central Asia. The successive migrations of nations have already more than once been compared to oceanic waves. Such a wave seems traceable previous to the dispersion of the Northern Aryans. Here and there on the coasts of Europe on narrow spits of land, defended by mountain ranges or by almost impenetrable cold, are to be found remnants of a race, once, it may be believed, numerous, now almost extinct. The Basques in Spain, and the Lapps* in Scandinavia, are supposed to be the last survivors of a family of nations that spread not only over those peninsulas, but over Denmark and these Islands, if not over almost the whole of Western Europe. Whether even they were the earliest human inhabitants of Great Britain is still a moot question.

The Stone Age is the earliest of which we have any remains, either in these islands or in Scandinavia. If any of the people of this period belonged to the Aryan family, during their wanderings from Central Asia our predecessors had lost most of the arts acquired during a settlement for some time in a country possessing a diversified surface and various capabilities. The period of which we are now speaking has been identified with that of the pine forests of Denmark, amid which the Scotch fir, now no longer known in that country, raised its massive head. No such peculiarity is known to have existed in the Flora of Great Britain, but many a wild beast, now unknown to us, some even extinct or verging on extinction, roamed through the forests as yet untouched by the axe of the woodman, sank into quag-mires that never quivered beneath the footstep of man fearful of nature's wonders, or made its home in the cave that served for a dwelling-place, or the model of a dwelling-place to the biped, whose nature was but little raised above his quadruped competitors in the struggle for life. Traces of many of these extinct animals existed down to quite modern times. Many an animal has died out within historic times, and many more in the long ages that preceded this. Such a change as the introduction of man must have had an immense effect upon the brute creation.

As late as in the time of David the First of Scotland, beaver skins

* I know not whether the Esquimaux are supposed to be ethnically connected with the Lapps and Finns, but many of the peculiarities of the earliest of our predecessors have been compared to the present habits of these remarkable tribes, and one of the motives put forward as a reason for research in Arctic regions is that the habits of the people to be discovered there would probably throw much light on the condition and mode of life of our own remote ancestors.

XUM

formed articles of commerce; wolves were not exterminated till after Alfred's reign in the more civilized portion of the island, and at this early time we find, besides all the still-existing deer and boar (the wild beasts *par excellence*, the Greek θήρ and φήρ, Lat. *fera*), the great fossil elk, the reindeer, the goat, three kinds of wild oxen, the auroch, or European bison, the brown bear, and the cave bear. Fiercer and more formidable than these again were the hyænas a rhinoceros, an elephant or two, it is said a mammoth, even a mastodon, a tiger, and another beast of the same family, larger and more terrible.* These had to be contended with by the early inhabitants of this island; these they subdued, and in many cases devoured. But though such a diversity of animals stocked the land, food was not too plentiful. Either man feared to taste the unknown flesh of many of these quadrupeds, or he was unable frequently to master the larger or the fiercer among them, with the ill-made and clumsy weapons he then possessed.

A mere taste for shell-fish would scarcely explain the large heaps of their remains, principally those of periwinkles, but also whelks, oysters, and scollops, that have been found in many parts of Scotland, the Orkneys, Denmark, Scandinavia, and even the American coasts, did we not remember that flint-tipped arrows and stone axes and hammers would avail to kill but few deer, wild oxen, or wild horses, whilst sheep were scarce, and whales but seldom floundered into creeks or bays where they could be despatched by navigators of single-tree canoes (Einbäum), fashioned by stone axe and hollowed by fire. Wretched must have been the condition of these makers of the kitchen-middens (Kjöckkenmoeddinger), only to be compared in poverty, though contrasting grandly in endurance, with the grub-eating savages of Australia.

There is a great interval between the chipped flints found in earliest strata and the ground and polished celt or delicately-formed arrowhead (compare Figures 6 and 7 with 1 and 2); besides two distinct modes of burial, both evidently belong to the Stone Age; and Dr. D. Wilson† thinks, that he finds traces of an earlier race, whose long, narrow, boat-shaped skulls denote a lower grade of civilization concurrent with these rougher implements. To these people he would attribute all the oldest and roughest remains of the Stone Age. The editors‡ of the 'Crania Britannica,' on the other hand, see no distinction so decided as to warrant division of this kind from the small amount of data as yet acquired. Where such authorities disagree, it is not for us to decide; at the same time, we cannot help thinking, that the learned editors of the last-mentioned work have furnished almost evidence enough to confirm Dr. Wilson's theory, whilst the

* "In this island, anterior to the deposition of the drift, there was associated with the great extinct tiger, bear, and hyæna of the caves in the destructive task of controlling the numbers of the richly-developed order of the herbivorous mammalia, a feline animal (the Machairodus latideus) as large as the tiger, and to judge by its instruments of destruction, of greater ferocity."—Owen's 'Brit. Fossil Animals,' p. 179.

† Prehistoric Annals of Scotland. ‡ Messrs. J. Thurnam and J. D. Davis.

increase of skill in manufacturing stone implements would serve to confirm whatever evidence there might be. Of one fact there is but little doubt, that some of our predecessors in this island had a practice still common amongst some of the tribes of North America, *viz.* that of flattening the skulls of their children by compression during infancy.

There is, then, still something to be done in clearing up the early ethnology of this country. It seems clear, however, that some race, probably Turanian, dwelt here before the Kelts landed on these shores, but whether this previous race had themselves crossed the Straits of Dover or had migrated before the sea broke through to separate us from some of the turmoil of Continental strife, as has been adduced from the Flora of the period; or, again, whether they had been anticipated by an earlier race—that race which left its flint weapons at Hoxne, dwelt in numbers about Bedford, with a stone killed an elephant, where Gray's Inn Lane now stands, and dwelt in caves at Brixham,—we are not as yet in a position to state with certainty.

But to turn from the people to the remains of their productions: the earliest dwellings of all seem to have been natural caves; then holes artificially made; next after these, and in imitation of them, we find in Scotland underground dwelling-places formed of large unhewn stones without cement of any kind; these are called *weems*, from the Gaelic *uamha*, a cave. They sometimes consist of several apartments, being as much as 30 feet in length, and were evidently long dwelt in, from the amount of ashes and other remains left in them. They were roofed by causing large stones to rest on the sides, so as to lap over from the centre; and again, others were caused to project farther inwards, until they were sufficiently near for a single flag to bridge the interval. No nearer approach to the arch was attempted. Near many of these weems have been found circles of stone of some two or three feet in height, accompanied by stakes of hazel, probably used as the summer dwelling-places of the inhabitants of the subterranean cells during that portion of the year when the climate would allow them to escape the darkness, smoke, and listlessness below. Whether these circles were protections to tents or the outer rim of a species of wigwam, cannot now be determined; but we may well imagine the joy with which the cave-dwellers would leave their sunless, miserable holes for the upper air as soon as the climate permitted them to enjoy fresher air and more room.

But among habitations the Lake-dwellings (in German, Pfahlbauten, pileworks) are perhaps the most interesting. The remarkably dry winter of 1853–4 caused the lakes of Switzerland to sink far below their usual level. Some of the inhabitants of Meilen, on Lake Zürich, took advantage of this circumstance to enclose a portion of the land usually covered by the lake, but now left dry. In so doing, they used the earth on the inside of the boundary to make the embankment. In the soil thus used, they soon noticed the remains of many antiquities of some early race. This drew the attention of several learned men* to the spot, and in consequence of this, to like

* M. Aeppli was the first who recognized the value of these discoveries.

remains in other lakes where similar dwellings were soon discovered. These habitations beginning with the earliest portions of the Stone Age extend to the time of the Father of History in Greece, and even down to historical times in Switzerland.

Herodotus* speaks of a race of Thracians who dwelt on Lake Prasias,† who lived in huts constructed on platforms on the lakes. These platforms were originally constructed by the united labour of the community, but that after this every man on taking a fresh wife (and polygamy was common), was compelled to add three piles to the common stock. The labour of cutting, pointing, and then driving these piles, which are mostly of fir, but also of oak, birch, and aspen, when only stone axes could be used, must have been enormous. We find that at this early period the piles were small, not being more than 3 to 9 inches in diameter, but from 15 to 30 feet long, since the spot was usually so chosen that the water was about 20 feet deep. At Wangen alone upwards of 40,000 piles have been found.

In Switzerland, M. Troyon‡ says the piles were usually arranged parallel to the shore at a distance of from 100 to 300 feet, and from one to two feet apart. On this common platform were constructed circular huts of wood, interlaced with branches and daubed with mud. Portions of this daubing, burnt probably in the destruction of the dwellings (nearly all these habitations seemed to have perished by fire), have been found at the bottom of the lakes. The curve that these pieces of burnt clay give would require a diameter of from 10 to 12 feet. Allowing a diameter of 15 feet, and as much space for means of communication as for dwellings, the platform at Morges on the Lake of Geneva, which is about 1,200 feet long by 150 broad, would have held 316 huts, and these, with an average of four inhabitants to each hut, would give a population of 1,264. A similar calculation for the Lake of Neuchâtel would have afforded security to 5,000 people, whilst the whole of Western Switzerland would have contained upwards of 30,000 during the Stone Age, and more than 40,000 in the Bronze Period. Beneath his dwelling each man had a trap-door, through which, says Herodotus of the race of whom he spoke, it was only necessary to thrust a basket and leave it for a short period, when it might be taken up full of fish. Fishermen say, that shade is so grateful to these creatures that this is quite possible, but it sounds rather like what our old author was told, than what he had seen with his own eyes. Fortunately for us these trap-doors, or the interstices of the beams, became the receptacles not only of a great deal that must have been considered rubbish, but of much also that was valuable to the owners as well as to modern antiquaries. From the site of only one of these dwellings have been recovered not less than 500 bronze hair-pins of an ornamental character, a fact that looks as

* Book v. c. 16.

† Now Lake Takinos, in Turkey. It has been stated in the 'Revue de l'Instruction Publique,' that the remains of these very dwellings have been rediscovered by a M. Deville.

‡ See Plate, and a translation of a paper by M. Troyon in the 'Ulster Journal of Archæology,' vol. vii.

if the hair they were intended to confine was often in a dishevelled condition.

It is hard to imagine why people should have chosen such localities as these lakes for their habitations. No doubt, safety, first from wild animals, and afterwards from their fellow-men, was one of the primary reasons. Herodotus mentions that the Thracians, to whom we referred above, remained safe from the attacks of the entire Persian army. These men, however, dwelt far out into their lake. The Swiss, on the other hand, seem never to have gone farther than three hundred feet from the land, whilst their general distance was about one hundred. This, however, would probably afford sufficient protection against flint-headed arrows or sling stones, though we could hardly suppose it would have availed much against the fire-bearing arrows such as the Persians could have used. In Syria certain Christians are said to have escaped from the Mahomedans by living in such dwellings. Thus these platforms have been made use of down to late and historic times, and even in Switzerland fishing-huts constructed on this principle, according to M. Keller, existed on the Limmat, near Zurich, as late as the last century.

It is one of the customs of the day to compare the growth of nations to the growth of the individual, to speak of the education of a race as we should of the education of a child, and to talk of mankind as a body passing through all the stages that each member of the whole human family travels over. We all know how children delight in water, how boating, swimming, and fishing form some of the especial amusements of young people; may it not be that in the childhood of nations, when the earth was young, and tribes wandered about in the wantonness and playfulness, and with not a little of petulant quarrelsomeness, of children, similar likings and tastes led these young nations to choose a dwelling in the midst of the waters?

In order that an idea may be formed of the numbers of these Pfahlbauten, a list is subjoined of the principal lakes in Switzerland, in which they have been found, with the numbers attached. It will be seen that the surface of the country inhabited by the people of this time lay in the richer, more fertile, and less rugged part of Switzerland, in a line stretching across from north-east to south-west, and lying to the north and west of the Bernese Oberland. In Lake Constance have been found 16 (all of the Stone Period only). Wangen 1 (S*), Lake Pfäffikon 2 (S, *viz.* at Robenhausen and Wauwyl), Lake Zürich 1 (B and S, at Meilen), Lake Sempach 1 (B), Lake Inkwyl 1 † (S), Lake Luissel 1 (B), Lake Moosseedorf 2 ‡ (S), Lake Bienne 7 (S) and 11 (B), Lake Morat 1 (B), Lake Neuchâtel 26 (B and S), Lake Geneva 24 (B and S), Lake Annecy, in Savoy 1 (B), and Missbaumen 1 (S). The inhabitants of the Bronze Period migrated rather farther south than their predecessors in the Stone Age, whilst the latter alone dwelt as far north as Constance and Wangen.

Another style of habitation, also a species of lake-dwelling almost

* (S) represents the Stone Period, (B) the Bronze.

† A league south of Wangern, near Soleure.

‡ Near Hofwyl.

as remarkable as the Pile Works, was the *Crannoge*. This word, originally signifying in Irish a wooden house, is used in that country to designate an island artificially raised above the surrounding water, protected by piles, and not unfrequently heightened by wooden platforms over a foundation of stones. On two of the Swiss lakes, Lake Bienne* and Lake Inkwyl,† remains of this kind have been discovered; and in Scotland, at Carlinwark Loch, Kirkcudbright, a similar discovery was made with the usual accompaniment of a single-tree canoe. These canoes were good-sized logs, felled by stone axes, and hollowed partly by the same means, partly by fire. They were blunt-ended, as may be seen from several discovered in Ireland, Scotland, and Switzerland. Crannoges have also been found in the Loch of Leyes, Kincardineshire; Lochriaben, Dumfries; Loch Doon, Ayr; Loch Winnock, Renfrew; Dhu Loch and Loch Quien, Bute; in several small lakes in Nairn and Galloway, and apparently at Duddingston Loch, Midlothian.

Frequent mention of such buildings is found in the Book of the Four Masters, and other early native chronicles of Ireland, and these numerous allusions seem justified by recent discoveries. Attention was first called to these structures in 1837; 150 cart-loads of bones were taken from one spot at Lagore, on Lake Gobham, in County Meath.

Since then nearly fifty others have been examined in the counties of Roscommon, Leitrim, Cavan, Monaghan, Limerick, Meath, Westmeath, Down, King's County, and Tyrone. The piles of these buildings were from four to nine inches in diameter, usually in a single row, placed in the form of a circle or ellipse, cut with a hatchet of some kind and interlaced with wattles, and sometimes mortised with cross-beams. The remains discovered in these situations show that they were in many cases inhabited during the early period designated by the Stone Age, though history and some of the relics betray that they continued to be used to a much later period. Sir Phelim O'Neill was besieged in one of the wooden islands on Lake Roughan, near Dungannon, as late as the time of the Civil Wars under Charles I., and he could not be dispossessed until boats were brought from Charlemont to enable the besiegers to approach the island. The earliest historical notice of such a dwelling refers, strangely enough, to the one first discovered of late years. In the same work of the Four Masters mentioned above, it is stated that the island at Lagore was plundered and *burnt to the ground* by a chieftain of Meath, A.D. 848. Most of these places exhibit traces of having been occupied for a long period. They are strongly fortified with wood and stone, and usually completely separated from the shore, though some have causeways remaining. To the same cause which led to the building of Crannoges in the Irish, Scotch, and Swiss lakes, we may attribute the early settlement

* At the Steinberg, near Nidau, in the northern part of the lake, there is a Crannoge of between two or three acres in extent belonging to the Bronze period. Rousseau's retreat, Peters Insel, and the little island close by it, owe their origin to this cause.

† Described by M. Morlot. This lake has a muddy bottom, entirely free from stone, except the rubble brought by human agency to make this Crannoge. The portions of pile still remaining are of chestnut, black and shining as ebony.

in troublous times of the isles in the Adriatic, by the Veneti. The defence was perfect against the style of the warfare of many succeeding ages, and the security of Venice did much to establish the independence and commerce of Northern Italy in the Middle Ages. We owe, then, to the inventors of the Crannoge, a debt of gratitude for much they could scarcely have anticipated.

Of the character of house or hut erected on these platforms it is not possible for us to say much. In the year 1833, Captain Mudge discovered in Drumkellin Bog, in Donegal, a log hut, which, from various causes, may be assigned to the Stone Age, though the latter period of it. This cabin was built of oak planking; it was twelve feet square and nine feet high, and though so low, it was divided into two stories of four feet each. The planks were formed by splitting trees, and one tree in most cases would make only two planks. The framework of the building was mortised together, and the roof was flat. A stone celt was found inside, which exactly corresponded to some of the cuts on the beams. Near this hut, which seems to have formed one of a palisaded village, were discovered a leathern sandal, a flint arrow-head, and a wooden sword, all of the same apparent age. From this we may conjecture that the earlier inhabitants of the Crannoges had dwellings which served for little better than sleeping berths. These are the principal styles of dwelling inhabited at this early period, and certainly the complaint cannot be made that we have servilely copied their architecture. An imitation of a Weem, a Pilework, or a Crannoge would assuredly appear like a novelty at the present time.

The weapons and implements of the Stone Age reveal to us the condition and civilization of the people of that time. Celts (Latin *celtis*, a hatchet) were made at first by chipping stone so as to form a rude blade, somewhat of the shape of a woodman's axe. As men improved upon their manufacture, or, according to some authorities, in the second period of the Stone Age, the stone was ground down so as to form a smoother edge, and for this purpose a harder and less brittle stone could be used.* How handles were fixed to these awkward implements may be conjectured from the Plate which accompanies this paper, and which shows how such tools are used by South Sea Islanders, and exhibits such handles as have been found.† That they were used for chopping wood we have evidence in the marks on the wood corresponding to the celt found beside it, and we may guess that such handy implements could not but be made available in war and in the chase. The stone (No. 6 in Plate) was found beside an elephant's bones, which was probably killed by it, beneath Gray's Inn Lane. In order to divide

* Messrs. Jahn and Uhlman state that at Moosseedorf they found Flint and Rockcrystal used in the earliest period, whereas afterwards serpentine, gabbro, jasper, agate, and opal occur.

† The celts probably were more easily injured in the using than the handles, whilst the latter were made of materials sooner destroyed by time. The plate contains very nearly all the handles that have been discovered in Europe, except the one in the British Museum, though the number of celts is almost innumerable.

the stone, these poor savages seem to have had saws made of chippings of flint stuck in the slit of a wooden knife-like handle. Some stones marked with grooves such as would be made by these primitive saws, are to be seen in the British Museum. Flakes of flint were also used for tipping arrows and lances, and these, in time, were manufactured with great delicacy, so as to present barbs to add to their destructive power (*see* Fig. 5). Stone hammers and mullers are found in considerable quantities, and seem to have been employed long after the metals were introduced into finer works. Some of the later of these hammers and axes are pierced with holes for the reception of a handle, a refinement not attempted in the earlier stages, when they frequently had a groove for catching a withy or cord to clasp the head. Querns, or small hand-mills, appear with the earliest remains, and thus prepare us to find corn amongst the relics of this primitive people at the bottom of the Swiss Lakes. These querns have not disappeared very long from use in remote parts of Scotland.* We should not be greatly astonished to find one in use even in the present day in such localities as those in which spinning-wheels are still employed, which latter invention dates back to the same period, as is testified by the *whorls* frequently brought to light, and by the remains both of *nets* and of rough material made by some process analogous to weaving. Needles, pins, bodkins, awls, fish-hooks, and various productions of a like character, were made from the bones of various animals, which were first split, in order that the marrow might be extracted, and were then manufactured into articles of various shapes, some so remarkable that it is difficult to imagine their uses. We can only wait to see whether the savages at the North Pole, or elsewhere, possess similar implements. A curious cup was found in the Orkneys, fashioned from the vertebra of a whale.

Stone formed the material of which some of the domestic utensils also were constructed; for instance, plates of slate have been found, as well as chafing-dishes, ladles, two carved cups (like queches, used now for whisky), bowls, and what can only be described as a tureen of stone; but pottery was not unknown, though of the roughest kind, and it was but partially burnt, fashioned and ornamented only by the hand with the thumb-nail, without the assistance of a wheel. Ornaments of bone, fish shells, ground down so as to form rings, amber, coal, and beads of a variety of stones, have been found in some of the tombs, showing traffic or importation from a considerable distance in some instances. Wood was also used for heavy beetles, &c.

Whilst speaking of the implements used by the people of the Stone Age, it is only right to mention that several circumstances in historic times point to an early use of such instruments. In many instances we find stone axes and knives used in sacred ceremonials, where naturally we may imagine that an antiquated state of civilization was

* In the reign of Alexander III. of Scotland, A.D. 1284, the following law was passed against querns:—"No man sall presume to grind quheit, maishlock, or rye with hands mylne, except he be compelled be storm or be lack of mills quhilk sould grind the samen."

kept up. Thus Zipporah and Joshua both used a stone for circumcision, pointing to a strong probability in favour of the use of stone in the days of Abraham. Hannibal * used a stone wherewith to crush the head of his sacrifice on a very solemn occasion—again a Semitic race using this weapon. The priests of Montezuma,† when America was first explored, employed the same material for sacrificing, though metals were well known and in constant use for ordinary circumstances. In like manner we read that bronze implements and utensils were used by some of the mountain tribes of Kurdistan in the time of Xenophon,‡ as they still are by certain African nations.

Of burials, there seems to have been various modes during the one division of time which has been called the Stone Age. At first the body was placed in a small cell in a crouched attitude, the knees supporting the chin and the hands crossed on the breast or hanging at the sides. After this, and probably by a different nation, the body was burnt and the ashes enclosed in urns. A third period, which seems to commence with the Bronze Age, is characterized by burying the body at full length, a practice continued ever since its introduction in this island. Coffins were frequently of oak. They are sometimes made of a tree split and hollowed, the roughness of the splitting affording a means of fastening on the lid. The usual tomb during the first of these periods was what was called a kist (*kist-vaen*, Gael. stone chest), a small chamber of rough, unhewn flag-stones. Not unfrequently several kists were placed together, forming what has been called the Chambered Barrow, of which some very fine specimens were opened by Sir J. Colt Hoare, in Wiltshire, during the last century. The cairn of stones piled around the body is a very early style of monument, sometimes intended as a mark of honour, sometimes of dishonour. A heap of earth would naturally be connected with this monument, either in the form called the Long Barrow, like a gigantic grave, or the Bowl Barrow, resembling an inverted bowl, or the Bell Barrow; in some places, especially in Scotland and the Orkneys, a Conoid Barrow. At a later period stones were placed on the top and around the barrows, thence named Crowned and Encircled Barrows. These are common in Scandinavia,§ and probably were introduced into this country from thence. Of a similar date are the Twin Barrows, where one vallum encloses two mounds, usually of different sizes.‖

* Livy, lib. xxi. c. 45.

† The Mexicans used many instruments similar to those of our forefathers. Their mode of fixing the heads of their hatchets to the handles shows this. Clavigero says, "The Mexicans made use of an axe to cut trees, which was also made of copper, and was of the same form with those of modern times, except we put the handle in the eye of the axe, while they put the axe in the eye of the handle."

‡ Xenophon, Anab. lib. iv. 1, § 8.

§ Numerous and remarkable instances of these forms are given in N. K. Sjöborgs 'Samlinga för Nordens Fornalskare.'

‖ Stukeley gave the name of Druid Barrows to those which contained jet, amber, and glass beads, cups, &c.; but these seem to have belonged to females, and not to deserve separate classification.

Some of the Scandinavian barrows are marked out in strange shapes by rough blocks of stone, placed sometimes in geometrical figures, more frequently in the figure of a ship, with rowers, benches, masts, &c. These would indicate a similar taste to that of the later inhabitants of the same peninsula. It is not unlikely that many of the *things* or parliaments were held in these enclosures.

It was said before that the inhabitants of the Stone Age either had forgotten the use and manufacture of metals in their dispersion, or had belonged to a race outlying the family of Aryans, and were unacquainted with the arts of the great Indo-European nations. Suddenly the metallurgic art revived, and with it a higher condition of cultivation and of taste. Immediately upon the Stone Age we come to a Bronze Age. Here and there * a few pure copper implements are discovered, but these are scarcely sufficient to warrant a belief of a general Copper Age ever existing throughout Europe.† The introduction of bronze, then, is most interesting, especially to Englishmen, since we know of no source whence one of the component parts of this alloy,‡ tin, could have been procured, save the early wrought tin mines of Cornwall. On the Continent the Bronze era is supposed to have begun with the immigration of a new race. The Northern Archæologists believe that bronze marks the handicraft of the Kelt. No such change is observable in Britain.

In the midst of the Stone Age we have seen that a great improvement in the mode of manufacturing implements accompanied a difference in the conformation of the skull, and from that period on to the times of the Anglo-Saxons no great diversity in the shape of the cranium is observable. It seems probable, then, that in the first period of the Stone Age a cymbecephalic race, akin to the Basques, Lapps, and Finns, dwelt in this island or in some portion of it; that a Keltic race, the first wave of the Aryan family, passed over from the Continent armed with better-made stone § weapons and endowed with greater capabilities of improvement, and, according to the hateful theory of modern colonizers, when the superior civilization met the inferior, they "improved the former off the face of the earth;" that these Kelts procured by some means, either by contact with Phœnician or Iberian immigrants, or some local tribe, of which we have now no

* In the Museum of the Royal Irish Academy, several specimens of copper celts are collected. See the Catalogue, edited by Sir W. R. W. Wilde. It is not unlikely that the Copper Age may have existed longer in Ireland than in these islands, where tin is so abundant.

† In North America, a Copper Age lasted a considerable time. This was owing to the immense stores of native copper to be found on the shores of Lake Superior. The Indians could fashion this copper with their stone hammers without any knowledge of metallurgic arts properly so called.

‡ The ancient bronze is always of certain fixed proportions of *tin* and copper. Zinc seems to have been unknown for long ages afterwards.

§ The Kelts, we must imagine, had lost during their migrations the whole practice of the metallurgic arts known to the entire family when in Asia. This was almost a necessity from their wanderings, though the traditions, and, to some extent, the knowledge of the working of metals in a rude manner had not been completely forgotten.

trace, dwelling about the Cornish mines, or perhaps by some revival of the old metallurgic arts that they had half forgotten, the metals from which they formed arms of far greater power and beauty than they had hitherto possessed, and with the accession of strength which these gave them, some portion of the tribe returned to the Continent reinvigorated; they infused fresh spirit into Northern Gaul and conquered the Cimbric, and then the Scandinavian, peninsulas. This seems a probable explanation of some facts which it appears otherwise difficult to connect.

We may believe, then, at all events, with regard to our own island, that the Bronze Age brought no new race, and we may be prepared to find that no immediate variation took place in style of dwelling or of tomb, nor even in the implements of warfare and of industry, any further than the introduction of a useful and at the same time expensive material, caused a general improvement in all the comforts and exigencies of life. The stone celt formed at first the model for the metallic, but gradually, step by step, appliances, not producible with the old material, were introduced. A thin flange of metal to secure the blade to the handle converts the celt into a palstaff. A loop of the metal (as in Fig. 8) serves to give the gut or tendon a firmer purchase in tying on the shaft. At last the celt was made hollow to receive a staff in its socket.

Bronze swords must have been very different weapons from anything that preceded them, as only bone could have been used for this purpose before. In many cases we find these of great elegance (see Plate); the blade was in the shape of the spear-wort leaf, tapering towards the hilt, bulging as it nears the tip, adding, as beauty implies utility, weight to the point of percussion. The potter's wheel soon came into fashion, the ware was better baked; attempts were made to imitate natural objects in the decorations, and regular mechanical ornamentation took the place of the old thumb-nail pattern. Needles could be made more delicate, ornamental hair-pins and brooches were more finely wrought, netting and even crochet were not unknown; fruits, such as apples * and plums, were split and dried for winter use. These were some of the improvements observable in the Bronze Age. A careful study of the relics in the British Museum, and the Plates in the Papers of Drs. Troyon and Keller, and in the Catalogues of the Royal Irish Academy Museum, of the Museum of Northern Antiquities at Copenhagen, and in Lindenschmidt's 'Heathen Antiquities,' would well repay the trouble it might occasion, by the clearness with which it would bring the condition of our ancestors before us.

Concerning the Iron Age, less need be said than about the former periods. We are now verging closer on history.† On the Continent

* In the last No. of the 'Quarterly Journal of Science,' p. 85, will be found a list, prepared by Professor Heer, of the plants discovered in connection with the Swiss lake-dwellings.

† It has been supposed by some of the Northern antiquarians that in Norway, where iron is so abundant and in a form easily worked (magnetite ore accompanied by common fluxes) that an Iron Age, to which no relics have as yet been definitely assigned, preceded the Bronze era.

it is said that everything of iron manufacture bears an impress, more or less distinct, of the influence of Roman civilization. We know not whether the same may be true of England or not; but it is certain that iron was in use, though tolerably scarce * and valuable, at the time of Cæsar's invasion. The perishable nature of this metal has prevented many articles manufactured of it from being preserved to our day. We consequently are less acquainted with this Age, so far as it is prehistoric, than with those that have preceded it. The introduction of iron, like that of bronze, was of course gradual. In Denmark bronze axes with iron edges, and in Scotland a bronze spear head with an iron core mark this stage. Two distinct differences are to be marked as coincident with the introduction of iron. As with bronze we find golden ornaments, so with iron do we find for the first time silver used for articles of decoration. And again, as with the introduction of a new race, or the development of a new stage of civilization in the Stone Age, we first come upon the use of cremation and funereal urns, so at this new stage we observe a return to the old mode of *burying* the dead out of their sight; but not as formerly in a couching posture, but at full length. The man returns not to the womb of his mother-earth to be again absorbed into her substance, but he lies like a warrior taking his rest, awaiting the trumpet that shall again summon him to perform his duty much as it had been performed here, either renewing the conflict as of old or sharing in some way the triumph for victory won.

These are the principal divisions of the Prehistoric Times, as far as science has as yet been able to decipher the records of these early races from the language, the antiquities, and the monuments of much that is anterior to all written records. Whether further researches will tend still more to subdivide these we know not. Within the last few years much has been revealed. The Swiss *savans* are on the alert, the Danish and Swedish archæologists are translating Sagas and rummaging kitchen-middens and cromlechs, our own antiquarians are not a whit behind, but flock to every new discovery, comparing, measuring, and describing with an accuracy and a care which must in the end produce some considerable result.

We append a classified table of the Fauna of the Swiss Pfahlbauten, taken originally from Rutimeyer's monograph on that subject, and enlarged by Lubbock from other works of the same author. It shows the wild enemies with which these early people had to contend, and also exhibits how far they had subdued these enemies and turned them into useful assistants.

* "Nascitur ibi. . . . regionibus in maritimis ferrum sed ejus exigua est copia." —Cæsar, De Bell. Gall. lib. v. c. 12, § 5. Herodian speaks of the Britons wearing "iron about their stomachs and necks, which they esteem as fine and rich an ornament as others do gold."

Rutimeyer's Table, enlarged by Lubbock.

		Stone.				Bronze.			Iron.
		Mooseedorf.	Wauwyl.	Robenhausen.	Wangen.	Meilen.	Bienne.	Concise.	Auvernier.
1. Brown Bear	Ursus Arctos	2	.	•	2	+	•	+	•
2. Badger	Meles vulgaris	2	2	1	.	+	•	+	•
3. Martin	Mustela foina	2	3	.	.	.	.	(×)	•
4. Pine Martin	„ Martes	2	3	.	.	1	•	(×)	•
5. Polecat	„ putorius	2	2	+	.	.	.	.	•
6. Ermine	„ Erminea	.	2	.	.	.	.	.	•
7. Otter	Lutra vulgaris	1	.	+	.	.	.	.	•
8. Wolf	Canis Lupus	.	1	+	(×)	+	•	+	•
9. Fox	„ Vulpes	3	3	1	1	(×)	.	.	•
10. Dog	„ familiaris	2	2	2	2	3	3	(2)	+
11. Wild Cat	Felis Catus	2	2	+	.	.	•	.	•
12. Hedgehog	Erinaceus Europæus	1	+	+	.	.	.	.	•
13. Beaver	Castor fiber	3	2	.	.	.	.	(×)	•
14. Squirrel	Sciurus Europæus	2	2	.	1	.	.	.	•
15. Marsh Boar	Susscrofa palustris	5	5	5	5	5	2	(×)	•
16. Wild Boar	„ ferus	2	2	2	.	.	.	.	•
17. Domestic Hog	„ domesticus	.	1	.	.	.	3	+	(×)
18. Horse	Equus Caballus	1	2	.	1	2	3	.	•
19. Elk	Cervus Alces	1	1	2	.	2	1	(×)	•
20. Stag	„ Elaphus	5	5	5	5	5	5	(×)	+
21. Roe	„ Capreolus	4	2	2	2	2	.	.	•
22. Fallow Deer	„ Dama	.	.	.	.	(×)	+	.	•
23. Ibex	Capra Ibex	.	.	.	.	1	.	.	•
24. Goat	„ Hircus	2	2	2	.	.	3–4	(×)	+
25. Sheep	Ovis Aries	.	1	2	.	(×)	3–4	(×)	+
26. Urus	Bos primigenius	1	+	2	.	.	.	+	•
27. European Bison	„ Bison	.	1	.	.	.	.	.	•
28. Ox	„ Taurus domesticus	5	5	5	5	5	5	(×)	+
29. Kite	Falco milvus	.	.	1	.	.	•	.	•
30. Goshawk	„ palumbarius	2	1	.	.	.	.	.	•
31. Sparrowhawk	„ Nisus	2	.	.	.	.	.	.	•
32. Ringdove	Columba Palumbus	1	.	.	.	.	.	.	•
33. Wild Duck	Anas Boschas	3	1	.	.	.	.	.	•
34. Garganey	„ querquedula	2	.	.	.	.	.	.	•
35. Heron	Ardea cinerea	2	.	1	.	.	.	.	•
36. Fresh-water Tortoise	Testudo Europæa	1	.	.	.	.	.	.	•
37. Edible Frog	Rana esculenta	3	2	+	.	.	.	.	•
38. Salmon	Salmo salar	1	.	.	.	.	.	.	•
39. Pike	Esox Lucius	3	2	.	.	.	.	.	•
40. Carp	Cyprinus Carpis	2	.	+	.	.	.	.	•
41. Bleak	„ leuciscus	1	.	.	.	.	.	.	•
42. Mouse	Mus sylvaticus	.	.	1	.	.	.	.	•
43. Hare	Lepus timidus	1	.	.	.	.	.	.	•
44. Chamois	Antelope rupicapra	.	.	+	.	.	.	.	•
45. Domestic Ox									
46. Ass									

Rutimeyer's Table, enlarged by Lubbock—(continued).

		Stone.				Bronze.			Iron.
		Moosseedorf.	Wauwyl.	Robenhausen.	Wangen.	Meilen.	Rienne.	Concise.	Auvernier.
47. Golden Eagle	Aquila fulva	.	.	1	.	.	.	.	.
	„ haliætus	+	.	.	.	.	.	.	.
48. Owl	Strix alves	.	.	.	.	.	.	1	.
49. Starling	Sturnus vulgaris	.	.	1	.	.	.	.	.
50.	Cinclus aquaticus	.	.	1	.	.	.	.	.
51.	Tetras bonasia	.	.	1	.	.	.	.	.
52.	Ciconia alba	2	.	2	.	.	.	.	.
53.	Fulica atra	.	.	1	.	.	.	.	.
54.	Larus	.	.	1	.	.	.	.	.
55. Swan	Cygnus musicus	.	.	1	.	.	.	.	.
56. Wild Goose	Anser segetum	.	.	1	.	.	.	.	.
57. Perch	Perca fluvialis	.	.	1	.	.	.	.	.
58.	Scardinius erythrophthalum	.	.	1	.	.	.	.	.
58.	Chondrostoma nasus	.	.	1	.	.	.	.	.
60.	Lota vulgaris	.	.	1	.	.	.	.	.

1 signifies a single individual.
2 „ several.
3 „ species common.
4 „ very common.
5 „ great numbers.
× „ a trace.
\+ „ added by Lubbock.

EXPLANATION OF PLATE.

At the top of the Plate is a Swedish Cromlech taken from a drawing in Sjöborgs Samlingar för Nordens Fornalskave. This is similar to many in this country which are sufficiently well known.

The view in the centre is taken with some modification from a conjectural restoration of the Platform of a Lake-dwelling at Wauwyl, on Lake Pfäffikon, in Switzerland, by Dr. Ferdinand Keller, and published by him in the 'Proceedings of the Antiquarian Society of Zurich.' A corresponding view from an earlier paper by the same author forms the frontispiece to Sir Chas. Lyell's 'Antiquity of Man.'

The figures on each side of this view represent a bronze sword and dagger.

1. Stone celt with wooden handle, apparently of pine, 13¾ inches long, found in County of Monaghan. From Sir W. R. W. Wilde's Catalogue of the Museum of the Royal Irish Academy.

2. Stone celt with bone handle, copied from Linderschmidts Altherthümer unserer heidnischen Vorzeit. About 8 inches long.

3. Stone celt with wooden handle, from Little Fish River, in Africa. From Wilde's Catalogue.

4. A bronze celt with handle, found in the Boyne, near Edenderry. 13¾ inches in length. This is the only instance as yet discovered of a metal celt with handle.

5. Flint arrow-heads, found in Robenhausen and Geisboden (1846), showing the mode of attaching them to the shaft. F. Keller.

6. Flint implement, found near the skeleton of an elephant under Gray's Inn Lane.

7. Flint implement, from the valley of the Somme.

8 and 11. Restorations showing the probable mode of affixing bronze celts to handles. From Wilde's Catalogue.

9. Stone implement, used as an adze by Pacific Islanders. From Squier and Davis, Ancient Monuments of the Mississippi Valley.

10. Bronze needles, apparently for crochet and netting. From Swiss lake-dwellings. Keller.

12. Bronze brooch from Swiss lake-dwellings, approaching in shape to modern safety pins. Keller.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

THE events of the past few months in the agricultural world have belonged rather to the business than to the science or the art in which we are interested. The cultivators of light barley-growing soils have been excited by the probability, or rather the possibility, that the malt tax, which they believe to injure them, may, by a strenuous agitation for its removal, be reduced or taken off; and the cultivators of the clay-land districts of the country have been roused to something like indignation by the orders of the Home Secretary forbidding the travelling upon highways of the locomotive engines by which steam cultivation—so beneficial to their stiff wheat-growing soils—is accomplished. These have been the two chief topics of the agricultural newspapers, and neither of them is quite adapted for discussion here.

Beside these, some discussion has also arisen on other matters, rather, however, of social than of strictly scientific interest.

The Society of Arts has been at work through its committee, upon the Cottage-building difficulty — inquiring into the causes which retard the erection of houses for labourers in rural districts. And the English Agricultural Society has been engaged through a Committee of its Council, upon the subject of Agricultural Education. The idea entertained by some of the leading members of the latter committee seems to have been, that agricultural education means simply the education of farmers' sons; and that all the Society can undertake is to offer prizes for boys, the sons of farmers, who shall take honours at the local University examinations of middle-class schools. The results of professional education they declare incapable of being ascertained, or tested by examination—than which nothing can be more mistaken. It is perfectly easy to ascertain in this way the extent of any one's professional knowledge; and whatever immediate resolution may be pronounced by the Council, it is not likely that the general body of members will, in the long run, acquiesce in the proposal to throw the influence of a merely professional society into the great sea of general middle-class education, where it must be altogether lost. They will insist on limiting the efforts of the Society to the field of professional education, where the guidance and incentive of its examinations and rewards would be most effective.

There is yet another subject to be named in an agricultural review of the past quarter. The agricultural utilization of town sewage has been the subject of a paper from Baron Liebig, and of lectures before both the Agricultural Society and the Society of Arts. The conclusions to which practical agriculturists arrive on a consideration of this subject, are so opposed to those of the distinguished German chemist, that were it not for the sanction which they receive

from the best chemists of our own country, the practical farmer might very well hesitate to maintain the judgment he had formed. We do not pretend to a discussion here of the elaborate chemical report on this subject, which Baron Liebig has addressed to the Lord Mayor of London. But even the intelligent agriculturist can perceive one or two defects which it exhibits as a specimen of sound reasoning. In the first place, it evidently abandons the true Baconian philosophy in the method by which it professes to determine the composition and the value of the article it discusses.

The proper way to determine the composition of town sewage clearly is to obtain a fair and average sample of it, and subject it to analysis. Liebig, however, arrives at its value, not by examination, but by reasoning. He considers the food that is consumed in the Metropolis—the waste attendant on the cooking of so large a quantity—the average waste of the digestive process in adults and children —the quantity of urine and fæces voided by animals in the streets; and assuming that a certain proportion of all this will reach the sewers, he concludes what sewage is from what he thus believes it ought to be. This, however, is clearly not the sound or philosophical way of determining the point on which the whole of his subsequent reasoning rests.

Again, the reader of his report can hardly fail to notice a remarkable inconsistency in his valuation of the fertilizing powers of guano and of sewage water respectively. Guano he makes out to be agriculturally worth only 7*l.* 14*s.* per ton — a conclusion entirely upset by the actual fact, for the agricultural experience of the value of guano is large and long enough to make it certain that the market value, 12*l.* or 13*l.* per ton, is not more than agriculturists find it to be their interest to give. But the method by which he reaches so remarkable a result—namely, a discussion of only the ready-made ammonia, along with the phosphoric acid and potash which it contains, does not bind him when he values sewage-water. The urea, with its "potential" ammonia, as Dr. Ure called it, goes for nothing in the case of guano—but is all calculated, in the 7 grains per gallon allowance, at its full ammonia power in sewer water; and this is an inconsistency which must certainly diminish the influence of the paper published by the Baron on this subject. The practical agriculturist, moreover, who judges of the conclusion which it indicates, by his experience in the field, will certainly refuse his acquiescence. The ideas which it teaches, that the agricultural value of a manure can be determined anyhow but in the field—that the material put into the land in dung will all reappear in the consequent increase of the crop —that arable cultivation offers the best circumstances for the full realization of the fertilizing power of sewage, are all utterly opposed to the experience of the farmer. And, of course, the experience of the farmer must, after all, be conclusive on this subject. Once get the agricultural verdict, and it must be final—it is necessarily the true one. Whatever may be the prepossessions of the man of science there can be no appeal. Hence it is, that if we can show how the analogy of agricultural experience bears upon the sewage question, and, still better, if we can quote the records of actual agricultural ex-

perience of sewage elsewhere, in illustration of the treatment of the sewage of London, we shall have then obtained the only safe guide through the difficulties which surround the subject. And this was what, in the lectures before the Society of Arts and the Agricultural Society of England, was attempted. It was, indeed, subsequently alleged that the analogy of agricultural experience does not lead to the conclusion that it is the best policy to put sewage on grass land in quantity, as in a water meadow. It was declared that the farmer puts on his manure sparingly, carefully calculating how much the crop will pay for, and not applying more. But if agricultural experience proves anything, it proves that plants must be treated according to the nature of them. A rapid succulent growth, which is what we want in grass, is obtained by excessive manuring. The London market-gardener applies 60 to 80 tons of solid dung per acre to the cabbage crops of a single year. And it is perfectly consistent with this that the grower of a single acre of Italian rye grass, where succulent growth is also wanted, should put 10,000 tons of sewage on it in the course of a single year. But we are not dependent only on analogy to guide us here: they have for years and generations been putting 10,000 tons of sewage per acre over many hundred acres of poor land near Edinburgh. Here is a case which, as it seems to us, fairly closes the door on any further discussion. If ever there was a satisfactory and conclusive piece of agricultural evidence on the subject it is this—350 acres in extent, and 100 years in duration—it is altogether unassailable. By the use of sewage in quantity, these 350 acres are made to keep 2,000 cows during the season of growth. They must yield 50 tons of grass per acre to do it, or a ton of grass to every 200 tons of the stuff poured on. This, however, the advocates of minimum dressings declare to be a poor result. All we know is, that there is nothing like it anywhere else in England; and taking the character and continuance, as well as the quality of the produce into account, we do not suppose that there is anything like it anywhere else on the face of the earth. Add to this result that which Mr. Lawes observed at Rugby, where the produce was found to be in almost direct proportion to the quantity of the application, and the argument in favour of abundant dressings appears to be irresistible.

The whole discussion clearly shows that the best chance we have of turning the drainage water of our towns to a profitable agricultural account, rests on the plan which has succeeded at Rugby and at Edinburgh, where enormous quantities of dilute sewage, already in a putrid state, are poured over a comparatively small area of grass land, whose plants, both by leaf and root, feed and flourish on the ready-made food which is thus continually passing by them. We do not doubt that by-and-by the sewage water of London will be poured over grass lands in Kent and Essex—perhaps over the Maplin Sands, which Messrs. Napier and Hope propose to embank from the sea for the purpose; and, producing there at the rate of a ton of grass to every 200 tons or thereabouts of the filthy water utilized, we shall thus have food for an immensely increased herd of cows; and the elements of London sewage will be re-arranged in the more wholesome form of London milk.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

It has long been a matter of some doubt whether any perceptible disc could be observed where stars of the first magnitude were examined under very high powers in large telescopes. In most works attention is given to the *apparent* diameters of these stars, and the importance attached to the measure of this amount is daily felt in practical astronomy, and in particular in the determination of the parallaxes of stars. The most illustrious astronomers have occupied themselves with this question, and Sir W. Herschel has devoted to it several memoirs. According to this astronomer, the most delicate measurements did not perhaps give an apparent diameter to *Arcturus* exceeding the tenth of a second. This unexpected result agreed, however, with the observation of J. Cassini, who had observed, in 1720, the occultations of γ *Virginis*, and had concluded that the space between the two stars was thirty times greater than the real diameter of each of the components of this binary group. Until the present time these two celebrated observations have remained as the most characteristic types of the smallness of the apparent diameters of the stars; but since this epoch the progress in the means of sounding the distant regions of space has given the astronomer gigantic acromatic telescopes wherewith to repeat these observations. Moreover, although the method of occultations is preferable to all others, yet, as our satellite does not cover by its movement in the celestial sphere the most brilliant of the stars, further and more recent observations were desirable, in which new methods of determination should be employed. M. Chacornac has recently followed up this inquiry, and has given us some new determinations of the apparent diameter of Sirius. The process adopted is as follows:—A "*lunette prismatique*," made by Secretan, is employed, suitably provided with superposed rotary prisms, producing the phenomenon of the gradual extinction of the extraordinary image of a star; the two images of Sirius are then brought into contact, so that there is no interval between them. This disposition effected, the second image is made to decrease in intensity until it arrives at the azimuth of apparition; the interval which separates them from centre to centre is then compared, taking for unity of measure the diameter of the extraordinary image. Operating in this manner, M. Chacornac finds that, for equality of brightness of the two images, the interval is originally from centre to centre equal to any one of the diameters of the image, whilst it is from five to six times the diameter of the extraordinary image when the images are most dissimilar in brightness. If the power be then doubled, and the operation is performed in the same way as for the lower power, without making any change in the prismatic arrangement, the ratio one-fifth becomes suddenly one-twelfth. The result of numerous measurements made with telescopes of very different power is, that it has always been possible to reduce the extraordinary image of Sirius, even in using the highest powers, to an imperceptible point. The apparent diameter of Sirius, as that of

each of the components of γ *Virginis*, is entirely factitious, and owing simply to the brightness of its light. This may be verified by repeating the determination with any one of the planets Mars, Uranus, Neptune, or with the satellites of Jupiter. It will be remarked that the apparent diameters of these objects do not decrease by diminishing the brightness when they subtend a sensible angle in the instrument employed with the prismatic glass.

The subject of solar physics has attracted a great deal of attention lately, and an important memoir on the nature of solar spots has lately been communicated to the Royal Society, by Warren De la Rue, F.R.S., Balfour Stewart, F.R.S., and Benjamin Loewy, Esq. The authors have attempted to answer the following questions :—

1. Is the umbra of a spot nearer the sun's centre than the penumbra? or, in other words, is it at a lower level?

2. Is the photosphere of our luminary to be viewed as composed of heavy, solid, or liquid matter, or is it of the nature of either gas or cloud?

3. Is a spot (including both umbra and penumbra) a phenomenon which takes place beneath the level of the sun's photosphere or above it.

In answering the first of these it was shown that if the umbra is appreciably at a lower level than the penumbra, we are entitled to look for an apparent encroachment of the umbra upon the penumbra on that side which is nearest the visual centre of the disc. Tables are given in the paper showing the relative disposition of the umbra and penumbra for each spot of the Kew pictures available for this purpose. From the first table it is shown that 86 per cent. of the cases are in favour of the hypothesis that the umbra is nearer the centre than the penumbra, whilst 14 per cent. are against it. From the second table, in which only spots of high latitude are considered, 80·9 per cent. are in favour of the hypothesis, whilst 19·1 per cent. are against it. The result of these tables shows, therefore, that the first question may be answered in the affirmative.

When discussing the second and third questions, it was observed that the great relative brightness of faculæ near the limb leads to the belief that these masses exist at a high elevation in the solar atmosphere, thereby escaping a great part of the absorptive influence which is particularly strong near the border; and this conclusion was confirmed by certain stereoscopic pictures produced by Mr. De la Rue, in which the faculæ appear greatly elevated. It was remarked that faculæ often retain the same appearance for several days, as if their matter were capable of remaining suspended for some time. From an examination of tables showing on which side of the sun-spots their accompanying faculæ are mostly found, it would appear as if the luminous matter, being thrown up into a region of greater absolute velocity of rotation, fell behind to the left, and we have thus reason to suppose that faculous matter which accompanies a spot is abstracted from that very portion of the sun's surface which contains the spot, and which has in this matter been robbed of its luminosity.

Again, there are a good many cases in which a spot breaks up, in

the following manner:—A bridge of luminous matter, of the same apparent luminosity as the surrounding photosphere, appears to cross over the umbra of the spot unaccompanied by any penumbra. There is good reason to think that this bridge is above the spot, for were the umbra an opaque cloud, and the penumbra a semi-opaque cloud, both being above the sun's photosphere, it is unlikely that the spot would break up in such a manner that the observer should not perceive some penumbra accompanying the luminous bridge. Finally, detached portions of luminous matter sometimes appear to move across a spot without producing any permanent alteration. From all this it was inferred that the luminous photosphere is not to be viewed as composed of heavy, solid, or liquid matter, but is rather of the nature either of a gas or cloud, and also that a spot is a phenomenon existing below the level of the sun's photosphere. The paper concluded with theoretical considerations more or less probable. Since the central or bottom part of a spot is much less luminous than the sun's photosphere, it may perhaps be concluded that the spot is of a lower temperature than the photosphere; and if it be supposed that all the sun's mass at this level is of a lower temperature than the photosphere, then we must conclude that the heat of our luminary is derived from without.

Dr. Reichenbach, of Vienna, has made a curious experiment. The existence of aërolites, meteors, &c., which frequently fall to the earth, has led some persons to the belief that the cosmical space is filled with a dust which sometimes becomes agglomerated so as to form large and small meteors, while at other times it reaches the surface of our earth in the form of an impalpable powder. Dr. Reichenbach has attempted to show the existence of such a powder, by collecting some of the dust from the top of a high mountain, which had never been touched by spade or pickaxe; upon analysis he found this dust to consist of almost identically the same elements of which meteoric stones are composed—nickel, cobalt, iron, and phosphorus. The doctor considers that we must look for the source of phosphorus in our soils to this mysterious invisible rain, which henceforth must be regarded as quite as necessary for vegetation as the water which falls from the clouds. This very pretty theory would stand more chance of being believed in by scientific men if there were no such thing as wind; but under the present conditions of atmospheric phenomena the existence of dust on exposed surfaces is more likely to be a terrestrial than a cosmical phenomenon.

Chronicles of the progress of astronomical science for the past quarter would not be complete were we to omit to mention that the French Academy of Sciences has awarded the Lalande Medal, the highest astronomical prize in the gift of the Academy, to Mr. Richard Carrington, of Redhill, the indefatigable observer of solar spots. This is the greater honour, inasmuch as Anglophobia is by no means rare amongst members of the French Academy.

Proceedings of the Royal Astronomical Society.

Some very careful observations on radiant points of shooting-stars were communicated to this society at the meeting on December 9th, by Mr. A. S. Herschel. This subject is one which this observer has made peculiarly his own, and the mass of facts which is being carefully collected and collated by such observers cannot fail to bear valuable fruit at no very distant time. The present paper, consisting as it does principally of diagrams and tabulary matter, defies condensation, but we may state that they appear to lead to the conclusion that the length in miles of the luminous excursions of meteors depends not so much upon the mass of a meteor as upon the depth of the inflaming atmospheric stratum through which it has to pass, and that this in general is the same for all meteors. The author likewise supposes that there are two meteoric orbits, neither of whose semi-axes major differ more than a fourth part from radii vectores of the earth. This supposition agrees with the evidence adduced elsewhere, by Professors Newton, Erman, and others, to show that the August and November rings of meteors very nearly coincide in their dimensions with the orbit of the earth. It adds fresh support to the conclusion that meteoric orbits approach in general very nearly to the circular form, but offers no explanation of their frequent retrograde motions and large obliquities to the ecliptic.

Professor Anwers has communicated the results of his researches relative to the orbit of Sirius, and has deduced, by a new computation, in most cases from the original sources, the following most probable values of the elements from 214 equations of condition; comprising, with trifling exceptions, the whole accessible material of observations, which prove to be trustworthy.

Passage through lower Apsis . . .	=1793·890 years.
Mean yearly motion	=7°28475
Time of revolution	=49·418 years.
Eccentricity	= 0·6010

In our Chronicles we have given some observations by M. Chacornac on the apparent diameter of Sirius. This note formed the subject of a few remarks by Mr. Pritchard, the Honorary Secretary of the Society, at their December meeting. He commenced by saying that although the meaning of the author's term, *lunette prismatique*, was somewhat doubtful, it seemed to refer to what in England would be called a double-image prismatic micrometer eyepiece. The image of a star formed by a lens with a circular aperture is well known to be a "spurious disc," surrounded by a few coloured rings, the cause being the interference of the waves of light which have passed through the object-glass. The intensity of the light in the spurious disc diminishes from the centre to the circumference, where it is a minimum; the light then varies again in intensity through a succession of maxima and minima thus furnishing the rings. Suppose, then, two images of the spurious disc to be formed by means of the "rotary prisms" referred to by M. Chacornac, and which leave the ordinary

image unaffected, but gradually extinguish the extraordinary image, it is plain that those parts of this image which are of the least intensity will be extinguished first. Thus as the prism rotates, the extraordinary image of the spurious disc will gradually contract by extinction into a mere point at the centre of the disc. It will be observed that all depends upon the variation of the intensity of the light from the centre to the circumference of the spurious disc, formed originally in the focus of the object-glass. Nothing of the sort takes place with a planet, inasmuch as the light does not sensibly vary in intensity from the centre to the margin.

At the January meeting of the Society, the Astronomer-Royal gave a comparison of the transit-instrument, in its ordinary or reversible form, with the transit-instrument in its non-reversible form, as adopted at Greenwich, the Cape of Good Hope, and other observatories. In the use of the reversible transit the line of collimation is found by observation of a fixed mark, or something equivalent to it, in reversed position of the pivots; in the use of the non-reversible transit the line of collimation is found by observation of two opposite collimators, which have been adjusted one upon the other. In the determination of errors of level and errors of azimuth there is no difference of method requiring notice at present. Both systems are theoretically quite accurate; no constant error attaching to either of them if the instrument is rigid, its pivots circular, and the bearings correct. The points, then, which require consideration at present are not the great and fundamental principles of construction, but the smaller points of flexure, irregularity of pivot form, and bad bearings. The Astronomer-Royal's communication was occupied principally with the consideration of the effects of flexure. It will be impossible to follow in abstract the mathematical considerations respecting flexure of the axis, flexure of the telescope tube, and the geometrical effect of such displacements on the path of the optical axis of the telescope. The conclusion arrived at being, that on every point the non-reversible transit-instrument is superior to the reversible or ordinary transit-instrument as commonly used.

One of the most important contributions to Physical Astronomy which has been laid before the Society for some time past, was communicated by Mr. Huggins at the same meeting. It had reference to the much debated question of a lunar atmosphere. The author considered that some important information on the subject of a lunar atmosphere might be furnished by observing the spectrum of a star a little before, and at the moment of, its occultation by the dark limb of the moon. It is well known that, from ordinary telescopic observation of the disappearance of a star under these circumstances, no indications of a lunar atmosphere have been detected. From the absence of such indications "we are," according to Sir John Herschel, "entitled to conclude the non-existence of any atmosphere at the moon's edge having one 1980th part of the density of the earth's atmosphere." When, however, the observation is made upon the *spectrum* of a star before, and at the moment of, its disappearance, several phenomena characteristic of the passage of the star's light through an atmosphere

might possibly present themselves to the observer. If a lunar atmosphere exist, which either by the substances of which it is composed, or by the vapours diffused through it, can exert a selective absorption upon the star's light, this absorption would be indicated to us by the appearance in the spectrum of new dark lines immediately before the star is occulted by the moon. Again, if finely-divided matter, aqueous or otherwise, of the nature of "fog," were present in the moon's atmosphere (a supposition to which telescopic observation is opposed), or even any considerable amount of invisible vapour, the red rays of the star's light would be enfeebled in a smaller degree than the rays of higher refrangibilities. In this case the blue end of the spectrum would appear to fade, leaving the red rays comparatively undiminished in brightness at the moment of the star's extinction.

If, however, there be about the moon an atmosphere free from "vapour," but of some density, then, because of the greater refraction which the more refrangible rays of the star's light would suffer in passing through it, the blue end of the spectrum would continue visible for a very small interval after the red rays had disappeared. Even if the moon's atmosphere were not of great extent, but sufficiently dense, the spectrum would probably not be extinguished at the same instant throughout its length, but a lagging of the violet and blue rays behind the red would be perceptible. The star examined was *ε Piscium*, at its occultation of January 4 last; the telescope had an aperture of 8 inches in diameter, and a focal length of 10 feet. In the spectrum apparatus two prisms were employed—one having a refracting angle of 35°, the other of 45°. The spectrum was viewed through a small achromatic telescope of 6·75 inches focal length, furnished with an eyepiece magnifying nine diameters. The telescope armed with this special apparatus was directed to *ε Piscium*, about five minutes before the almanac time of the occultation, which was 5h. 53m. The clock motion carrying the telescope was carefully adjusted, and by this means the image of the star was kept exactly upon the narrow slit of the spectrum apparatus. During a period of three minutes up to the disappearance of the star, the spectrum was observed steadily and without interruption. On the first point of interest, whether any dark lines additional to those belonging to the star appeared, Mr. Huggins is unable to speak decidedly. The state of our atmosphere was constantly varying, in consequence of which the stellar lines were seen with more distinctness at some moments than at others. A few seconds before the extinction of the star, some lines in the red, which had not been before noticed, were distinctly seen. These lines, however, might have belonged to the star, and have been brought out by a greater steadiness of our atmosphere at that moment. The mode of disappearance of the spectrum of *ε Piscium* can be described with more certainty. It was expected that the spectrum would disappear by a sudden failure of its light; but such was not the impression produced at the moment of extinction. The appearance suggested an opaque screen, equal in length to the spectrum passing before it with a rapid motion in the direction of its breadth. On this occasion the spectrum, as seen in the instrument, was very

narrow. The duration of the blotting out of the spectrum in this manner, though it was so small that it might perhaps be called instantaneous, yet occupied an interval of time which could be appreciated. This interval did not differ greatly from 2-10ths of a second. The disappearance of the spectrum was not observed to be preceded by any failure of the blue or of the red rays; but the spectrum appeared to remain unaltered in the relative intensity of its different parts up to the moment of extinction. The advance of darkness upon the spectrum, since it occurred precisely in the direction of its breadth, swallowed up the rays of different refrangibilities throughout the whole extent of the visible spectrum. The difficulties which attend the successful application of spectrum analysis to the heavenly bodies are so great, that much importance ought not to be given to a single observation of which the results are *negative*. A series of spectrum observations of the occultations of stars, especially if the list included some stars of greater brightness than ε *Piscium*, might possibly afford information of interest and value.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

(*Including Microscopic Botany.*)

Cell-Formation, or Cytogenesis, is still a subject of dispute among Vegetable Physiologists. Mohl advocated the formation of cells by the intrusion of a fold from the wall of the mother-cell, and this view was also supported by Naegeli. Schleiden laid great stress on the action of the nucleus, or cytoblast, in transforming the mucilaginous or protoplasmic matter into a gelatinous envelope, which ultimately became a membranous wall of a cell. Others supported a free-cell formation similar to what is seen in the formation of sporidia in the ascigerous fungi. Karsten has recently taken up the subject, and says, that in every case the formation of cells is free, and that the septa, or partitions, when in opposition with each other, arise from these confluent membranes, and not from any development of the wall of the mother-cell.

Schacht has recently examined the spermatozoids in ferns and their allies, in mosses, charas, algæ, and fungi. He says that these bodies are formed from the contents of the mother cell in the interior of the antheridium; that they consist of a soft cell-like body, with two or more cilia, and having no cell membrane, but simply a protoplasmic layer, enclosing fluid and granules. There are three typical forms of spermatozoids. 1. In Algæ the spermatozoid is a minute, elongated, rounded or pointed cell, with one, two, or more cilia, often of different lengths. 2. In Equisetums and Ferns the spermatozoid assumes the form of a flat band, which gradually widens from before backwards, and is rolled up like a watch-spring in the parent cell; when liberated it assumes a closely twisted spiral form. 3. In charas, mosses, and lichens the spermatozoid is sausage-shaped, and

is rolled up like that of the ferns. The motion of the spermatozoid consists chiefly of a rotation round its own axis, by which it wriggles as it were through the water bearing the cilia in front. The duration of the motion varies from a few minutes to many hours. Spermatozoids may be preserved for microscopical purposes in a solution of tannin (10 grains to the ounce), and in a solution of corrosive-sublimate (1 grain to the ounce) or in glycerine. The cilia are best seen after the spermatozoids have been slowly dried on the object-slide.

M. Corenwinder, in a communication to the Academy of Sciences, Paris. details experiments which lead him to the conclusion that neither the flowers nor the leaves of plants exhale carbonic oxide, or other combustible gases. He found that leaves exposed to the sun with a notable quantity of carbonic acid present, absorbed CO_2 rapidly but did not exhale CO.

The able Horticulturist Knight stated, that according to his observations a high temperature favoured the production of male flowers, while a lower temperature gave origin to female blossoms. He accounted in this way for the sterility of many plants grown in high temperatures. Naudin, however, is not disposed to adopt this view. He has made observations for ten years at least, on Cucurbitaceæ, and he finds that the male and female flowers appear to be independent of the state of the temperature. The character of the blossoms of these plants is according to him intimately connected with peculiarities of temperament which vary in different species and races, and even among individuals of the same race. The races of melons, squashes, and gourds, which have been long cultivated in Northern Europe, are comparatively more precocious and vigorous under heat for ripening their fruit than those of the same species recently introduced from tropical countries. Cucurbitaceæ attain their period of flowering and fruiting sooner under the hot and cloudless sun of the South of France than in Paris, where they grow luxuriantly, but do not flower well.

Mohl has examined the flowers of Oxalis, Viola, Specularia, and Impatiens, and has shown that self-fertilization must occur in these cases. In these plants the small and closed flowers are the fertile ones. In them the anthers while smaller in number have more active pollen. In Oxalis Acetosella, for instance, the larger anthers of the closed flowers contain only about 2 dozen pollen grains, and the smaller scarcely a dozen; while in the normal flowers the pollen grains are very numerous. The tubes from the pollen in the closed flowers send out their tubes to seek the stigmas, even at a considerable distance. From his researches, Mohl concludes that it is not a general law in hermaphrodite flowers, that nature should permit fecundation by the pollen of another flower in preference to its own pollen. In Fumariaceæ he remarks that the transport of pollen from one flower to the stigma of another is impossible on account of the mode in which the anther and stigma are enclosed by the petals.

Professor Lawson refers to a very remarkable boulder, in the Trent Valley, in Upper Canada, which was visited by him in company with

the Rev. W. Bleasdell, M.A., rector of Trenton, on the 6th June, 1862, and which he proposed to name the Bleasdell boulder. The following measurements of it are given :—

Length, 44 feet; breadth, 24 do.; height, west end, 19 do.; height, east end, 22 do.; greatest width of base, 21 do.; longitudinal circumference, 114 do.; lateral do., 77 do.

It lies due east and west, and is surrounded by a grove of iron-wood, overtopped by maple and beech. The following plants were found growing upon this huge stone: Rubus strigosus, Ribes cynosbati, R. rotundifolium, Silene Pennsylvanica, Fragaria vesca, Mitella diphylla, Solidago Canadensis Abies balsamea, A. alba, Lastrea marginalis, Polypodium vulgare, Adiantum pedatum, Hedwigia ciliata, Leptobryum pyriforme, Bryum roseum, Scyphophorus pyxidatus, Peltidea polydactyla.

The most characteristic boulder plants in Canada are Parmelia conspersa, P. cyanea, Schistidium apocarpum, Polypodium vulgare, Hedwigia ciliata, and Scyphophorus pyxidatus.

The occurrence of organic matter similar in composition to lignite and peat, is said to have been noticed by MM. Cloez and Wöhler, on a meteoric stone which was observed to fall at Orgueil, in France. Besides the usual inorganic matters an amorphous black matter like humus was seen, which on analysis was found to consist of carbon, hydrogen, and oxygen. The analysis of this meteorite would lead to the conclusion that organized matter existed in the region whence it came.

According to Unger, the Eocene fossil flora resembles much that of Australia at the present day; and the Tertiary flora has a marked resemblance to that of North America.

Dr. Greville continues his observations on Diatoms, and he has recently described the following new species from the South Pacific :— Campylodiscus humilis, Melosira nobilis, Auliscus Australiensis, Rhizosolenia striata, Cymbella Lindsayana, Navicula Robertsiana, N. sulcata, Stauroneis decora, S. obesa, Mastogloia Macdonaldii.

Mr. Charles Martins, of Montpellier, has shown that in high mountains there is an extraordinary heating of the soil, compared with the temperature of the air. He remarks that a solar ray falling on the summit of a mountain ought to be warmer than one falling on the plain, since the latter has lost most of its heat in traversing the dense atmosphere below. This is confirmed by observations made on the top of the Faulhorn, by Peltier and Bravais, in August, 1842 ; and by Bravais and Martins, in September and October, 1846. No less than 125 observations were made, and these showed the mean temperature of the soil during the day to be 53°·1 Fahr.; that of the air being 41°·7. Since that time Martins has made observations on the heating of the sun's rays of the same space of soil on an open plain at Bagnères de Bigorre, and the Pic de Midi. The two points are distant horizontally nine miles, and they are under the same meridian. The Pic isolated from the Pyrenees chain, rises to the height of 9,439 feet

above the level of the sea, while the plains of Bagnères are 1,808 feet above the sea-level. It was found that the mean of the temperature of the air in the shade at Bagnères was 97°·0; on the Pic 92°·8. The mean excess, therefore, of the temperature of the soil above that of the air at the two stations, is as 10 to 17; that is to say, about double on the mountain. The heating of the soil on high mountains is more remarkable when we consider the greater cooling by radiation at night as compared with the soil of the plains.

This temperature of the soil is intimately connected with the vegetation. Ramond, during fifteen years, made thirty-five ascents of the Pic du Midi, and gathered seventy-one flowering plants on the cone at the top of the mountain. Martins collected 131 flowering plants on the highest cone of the Faulhorn, the superfice being 3½ acres, and the height of the mountain 8,803 feet above the level of the sea. According to Malmgren, Spitzbergen contains ninety-three flowering plants. Temperature may help to explain the number and variety of the species which grow on the summits of the Alps and Pyrenees as compared with the flora of Spitzbergen. In the former situation the roots of the plants are warmed by the soil to a much greater extent than in the latter. The heat of the sun's rays in Spitzbergen is absorbed to a great extent by the dense atmosphere above the soil. In Spitzbergen the ground remains frozen continually at the depth of little more than a foot, and the heat of the air and sun not acting powerfully on vegetation, the flora is reduced to a small number of plants. These live at a temperature only a few degrees above the freezing point.

It seems desirable that a similar series of experiments should be made on the plants found on the tops of the mountains of Scotland, as compared with those of the plains.

Dr. W. Lander Lindsay has given an account recently of the flora of Otago, New Zealand. Collections of plants were made by him in the settled districts between Dunedin, the capital of the province of Otago, and the Clutha river. These present a parallelogram of country about sixty miles long by twenty broad. It may be characterized as the lowlands or district of the plains, in contradistinction to the West coast region, which is that essentially of deep fiords with lofty mountain walls. It consists of a succession of plains and gentle uplands, with few hills of an elevation of more than 1,500 feet. Its flora may be said to represent the Eastern seaboard, the Eastern plains, and, generally, the settled districts of Otago. It differs materially from that of the Western Alps (which rise to 9,000 feet) of the central great Lake basins, and of the Western fiords, whose flora has, generally speaking, an alpine or sub-alpine character. Among the more characteristic herbaceous plants of the district are species of Olearia, Celmisia, Senecio, Cordyline, Panax, Drosera, Ligusticum, Thelymitra, Gaimerotia, Gahnia, Piltosporum, Plagianthus, Aristotelia, Nestera, Raoulia, Forstera, Dracophyllum, Gentiana, Veronica, Ourisia, Euphrasia, Muhlenbeckia, Pimelia, Fagus, Caladenia, Calerophus, Carpha, Uncinia, Hymenophyllum, Trichomanes, and Lomaria.

Fifty-eight natural orders, 147 genera, and 235 species, are included in his enumeration. He mentions five new species—Viscum Lindsayi, Celmisia Lindsayi, Poa Lindsayi, Aciphylla Colensoi, Crepis Novæ Zelandiæ, and exhibited drawings of them. There were also five species which had not been previously found in Otago; thirty were rare in Otago or New Zealand, or exhibited other interesting peculiarities of geographical distribution; twenty-five species were common to New Zealand and Britain; and twenty-seven were British plants naturalized. Hardy immigrant plants are gradually displacing the more delicate and rarer herbaceous natives of Otago and of New Zealand. In the majority of cases it is to the detriment of the colonist whose fields or pastures are destroyed by the luxuriant intruders, though in certain exceptional cases, for instance, in the pasture grasses and clovers, he is decidedly and largely benefited.

Among the British plants which are naturalized, or are becoming naturalized, near Otago, are the following:—Poa annua, Festuca bromoides, Lolium perenne (rye grass), Anthoxanthum odoratum, (sweet vernal grass), Holcus mollis, Phalaris canariensis (canary grass), Alopecurus agrestis (a kind of fox-tail grass), Phleum pratense (Timothy grass), Rumex acetosa, R. acetosella, R. crispus, R. obtusifolius (various species of Docks), Stellaria media (chickweed), Cerastium glomeratum, C. viscosum, Spergula arvensis, (spurrey), Brassica oleracea (cabbage), B. campestris (Swedish turnip), Nasturtium officinale (water-cress), Capsella Bursa-Pastoris, (shepherd's purse), Trifolium repens (white clover), T. pratense, (red clover), Vicia sativa (common tares), Plantago lanceolata and P. major (species of rib grass), Erodium cicutarium (stork's bill), Urtica urens (nettle).

Mr. McIvor reports in regard to the cultivation of Cinchona at Ootacammund, on the Neilgherries, as follows:—

1. Cinchona succirubra, Red bark, 102,344 plants.
2. C. Calisaya, Yellow bark, 2,137.
3. C. officinalis var. Condaminea, original Loxa bark, 4,494.
4. C. officinalis var. Bonplandiana (C. Chatmarquera), select crown bark, 232,980.
5. C. crespilla, 1,927.
6. C. lancifolia, Pitayo bark, 12.
7. C. nitida, 8,426.
8. C. sp., 2,769.
9. C. micrantha, 11,561,
10. C. Peruviana, 3,176.
11. C. Pahudiana, 425.

Mr. James M'Nab has made observations on some foreign Coniferous plants raised from seeds ripened in Britain. He remarks:—

"For some years past my attention has been directed to the Coniferæ raised from seeds ripened in Britain, and I have now to make some observations relative to the few species which have come under my notice, chiefly in the Edinburgh Botanic Garden. Beginning with Abies Douglasii, I have examined specimens taken from the trees originally in-

troduced by the late Mr. David Douglas, the botanical collector; some from seedlings introduced from North-west America during the last ten years; and some from plants (eighteen in number) raised from seed ripened in different districts of Scotland, and now growing in the Botanic Garden. The original trees in the Botanic Garden (introduced by Douglas), as well as those recently raised from seed direct from the American continent, are of a rich dark-green colour, having straight clean stems, while the majority of those raised from British ripened seeds have their leaves somewhat shortened, and of a yellowish green tint, with bare undulated stems, and branches more or less covered with resinous warts. Many of the plants raised from home-ripened seeds have a sickly look and a stinted appearance, notwithstanding that many of them had reached the age of from fourteen to fifteen years. The soil of the Botanic Garden is naturally of a light sandy description, and it may seem curious that the trees of the Douglas pine of foreign introduction should do so well, while the British seedlings should in so many instances dwindle away. In several counties in Scotland we are informed that fine trees of the Douglas pine are to be seen reared from home-saved seed. Soil, in connection with a more vigorous state of health of the seed-producing trees, may account for the present apparent luxuriance of the offspring. In several instances it has been found that specimen trees (not the original ones introduced by Douglas) are set down as British seedlings, and said to be as vigorous in growth as trees raised from imported seeds. Those who state this are probably not aware that, previous to British seedlings being produced, the Douglas pine was extensively propagated by layers and cuttings, and these layers and cuttings must now be noble trees. After British seedlings came to be produced freely, no more plants from cuttings were ever heard of. If a degeneracy exists, as I firmly believe it does, it would be well for cultivators to return to the original method of propagation by layers and cuttings, instead of trusting so much to home-saved seed. Several of those trees which produce cones freely are frequently stinted, and at a comparatively early age yield abundance of cones. It is universally acknowledged that in the case of the Scotch fir and larch, the healthiest seedlings are those produced by large vigorous trees; and that stinted trees, which often produce cones in great profusion, give rise to an unhealthy offspring. Such must also have been the case with some of the original Douglas pines, which had been placed in situations not altogether suitable for them, and at an early age became weak. The result is, that cones are freely produced; but the offspring, if any, cannot be relied upon. Plants, three or four years old, raised from home-saved seeds of the Douglas pine, as well as those of the Scotch fir and larch, look as healthy as those young plants of the same age raised from imported seeds. The constitutional weakness in the plants raised from British-saved seeds does not show at once, but at various periods from three to fifteen years after germination. Seeds of the Douglas pine are now being sent home freely, and ought to be eagerly sought after by cultivators. It does not always happen that foreign seeds will produce healthy vigorous trees. Some of those originally sent home by Douglas produced trees which do not assume the gigantic growth, and have not the fine green tints of vigorous trees. One variety, which was called the Abies Douglasii taxifolia, is of a yellowish green colour, with branches somewhat pendulous, having the stem and branches thickly covered with resinous warts. Although this tree is diminutive when compared with most of those introduced by Douglas, still it has an amount of vigour very different from seedlings raised from British-saved seed. We have in the Botanic Garden one of these pendulous trees, reared from a cutting,

standing side by side with the green upright form, proving in this instance that soil has not so much to do with the change as original constitutional weakness. I have also seen specimens taken from twelve seedling plants of Abies Menziesii, being part of the offspring of the noble tree now growing in the Keillour Muir Pinetum, Perthshire, the property of William Thomson, Esq., of Balgowan, and which is without exception one of the healthiest and finest trees of the kind in Europe. It was planted by the late Mr. Thomas Bishop, forester, Methven, about the year 1831. The tree grows in a deep, spongy peat soil, where it tillers freely, and cuttings stuck into the peat soon take root. The plants produced are very various, as seen by the specimens now exhibited. The seedlings were raised from seed presented to the Botanic Garden by Mr. Thomson during the year 1858, being from the first cones produced by the tree, and it may have happened that the male flowers were not perfected simultaneously with the female ones. In the neighbourhood various species of the Abies tribe exist in large quantities, particularly the Abies nigra, A. alba, A. rubra, and A. excelsa. As some of them stand within 50 yards of the Abies Menziesii, judging from the diversity of seedlings, I am inclined to think that some of the young female cones must have been fertilized with the pollen of some of the above-mentioned trees, particularly with that of the Abies nigra; as it is a remarkable fact that the nearer the seedlings approach to the Abies nigra, the more healthy and compact they become. Specimens of Abies Menziesii raised from home-saved seed, just received from Balgowan, exhibit much the same appearance as those raised in the Botanic Garden. Although healthy, none of them possess the vigour of a specimen taken from a young tree struck from a cutting eight years ago. The seedlings of Picea nobilis, raised from British-saved seed, vary very much, but none of them possess the vigour of foliage as exhibited by the large tree now growing in the Botanic Garden, raised from seed originally sent home by Mr. Douglas, or even the plants reared from layers and cuttings taken from the original trees. The British seedlings look well till they get about one foot high, at which size they begin to assume a yellowish tint, and finally decay. Many of the seedlings are now dead, the largest having attained the height of three feet. These circumstances prove that early decay is not altogether depending on soil, as layers and cuttings from the originally imported seedlings are as healthy as the original trees. Precisely the same remarks apply to the British seedlings of the Pinus monticola—all assuming a yellowish tint after they reach four or five years of age. These remarks may not be applicable to British seedlings planted in a peaty soil where the monticola seems to grow best. Such, however, is the case with the plants raised from home-ripened seeds now growing in the Botanic Garden, but not with those from imported seed. It may be said that layers and cuttings of coniferous trees, particularly of the Picea and Abies tribes, are not so very easily produced. With layers I would recommend the twisting of a small piece of very fine copper wire round the branch, sufficiently tight to compress the bark without bruising it, previous to being pegged into the soil. When so treated, the majority of them will be found rooted twelve or eighteen months after being laid, according to the nature of the wood. Young points not more than two years old should be used. Cuttings take a much longer time. They have been successfully rooted under hand-glasses at the base of a north-exposed wall, where no sun can reach them; also in pots well drained and filled with sand and placed in a cold frame."

At a meeting of the Microscopical Society of Edinburgh, Dr. Dickson lately gave the results of his observations upon the development of

the flower in *Mentzelia aurea*. He had been able to verify almost all the details given by Payer in his *Organogénie* as to the same genus. Dr. Dickson called attention to an important point to which Payer has not adverted—*viz.* the time at which the three carpellary processes make their appearance. He finds that the carpels are developed at a very early period. They are distinctly to be seen when only the stamens of the first three degrees have appeared, and are probably developed about the same time as the stamens of the second degree. The carpels are thus developed long before the great mass of the very numerous stamens.

This fact Dr. Dickson considers quite irreconcilable with Payer's idea that the andrœcium in *Mentzelia* and its allies consists of a plurality of whorls, in which respect Payer holds them to differ essentially from *Loasa* and its allies where the andrœcium consists of a single whorl of five compound stamens.

The fact that the greater number of the stamens do not make their appearance until after the carpels, taken in connection with the evident grouping of the stamens of the first three or four degrees, leaves, in Dr. Dickson's opinion, no room to doubt that the andrœcium of *Mentzelia* consists of a single whorl of five confluent staminal groups or compound stamens. The most important difference between these groups and those in *Loasa* consists in their being centripetally developed, as regards the axis, in the former, a mode of development analogous to that of the compound stamens in the Myrtaceæ, while in the latter the development is centrifugal, analogous to that in *Hypericum*, &c. In *Mentzelia*, as in *Loasa*, the staminal groups are superposed to the sepals. Although the difference in the evolution of the staminal lobes in the two cases is undoubtedly an important one, Dr. Dickson thinks that botanists would hardly be justified in separating the Mentzeliæ and Loaseæ into distinct orders, as has been done by Payer in his *Leçons sur les familles naturelles*. The analogy between the two groups in all respects excepting the staminal evolution, is so remarkably close, that it cannot but be satisfactory to be able to retain the old order Loasaceæ intact.

In speaking of climbing plants at a late meeting of the Linnean Society, Mr. Darwin says:—"The perfection of the organization of plants is forced on our minds by the study of the many kinds that climb. Let us look at one of the more highly-organized tendril-bearing climbers. It first places its tendrils ready for action, as a polyp places its tentacles. If the tendril be displaced, it is acted on by the force of gravity and rights itself. It is acted on by light, and bends towards or from it, or disregards it, whichever may be most advantageous. During several days, the tendril or internodes, or both, spontaneously revolve with a steady motion. The tendril strikes some object, and quickly curls round and firmly grasps it. In the course of some hours, it contracts itself into a spire, dragging up the stem, and forming an excellent spring. All movements now cease. By growth, the tissues soon become wonderfully strong and durable. The tendril has now done its work, and done it in an admirable manner."

Dr. Julius Haast, Provincial Geologist of Canterbury, New Zealand, gives, in his report of the Geological Survey of the Province, an account of the plants found on its mountain ranges in the interior. His collection includes specimens from about 1,000 feet above the level of the sea to the line of perpetual snow. He enumerates 450 flowering plants, and 42 Ferns, Lycopods, and Marsileads.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Few persons have devoted themselves to the study of a favourite subject with so much constancy as Schönbein. Many years have now passed since that industrious experimenter first discovered ozone and pronounced it an allotropic modification of oxygen. Pursuing the same subject, he afterwards arrived at the conclusion that when ordinary oxygen, such as exists in the atmosphere, enters into combination with oxidizable matters, organic or inorganic, in the presence of moisture, the molecule of neutral oxygen becomes split up into two oppositely active atoms, or, as he expresses it, undergoes "chemical polarization." One of these atoms, he believes, unites with the metal or other oxidizable matter, while the other combines with the water to form peroxide of hydrogen. The fact of the production of peroxide of hydrogen, as well as a metallic oxide, during the slow oxidization of metals, Schönbein long since placed beyond dispute, but his theory of chemical polarization required an experimental demonstration of the fact that exactly the same amount of oxygen combined with the water as combined with the metal.

This demonstration he seems now to have accomplished. In some recent "contributions to a knowledge of oxygen," * he gives a method of determining, with all necessary accuracy, the proportion of oxygen united in each case. There are some difficulties in the way of obtaining an exactly equivalent amount of peroxide of hydrogen, mainly depending upon the unstable nature of that remarkable body. The actual results, however, come so near, that no doubt is left of the truth of Schönbein's theory.

We leave the rather lengthy details of the experiments to those specially interested in the subject, who will find them in the place indicated below; but we may give a short outline of the author's method. He shakes an amalgam of mercury and lead, containing five per cent. of the latter metal, with some very dilute sulphuric acid of known strength, in a capacious flask partially filled with either atmospheric air or pure oxygen. After but a few moments' agitation, a perceptible amount of sulphate of lead is formed, and peroxide of hydrogen is found in the acidulated water. By taking a measured quantity of this water, and determining the amount of uncombined acid, the author arrives at the proportion of acid which has combined with the lead, and from the amount of sulphate of lead calculates the oxygen which has united to form oxide of lead. The peroxide of

* 'Journal für prakt. Chemie.' Bd. 93, pp. 24–60.

hydrogen he estimates in another portion of the water, by means of a standard solution of permanganate of potash.

The foregoing will show the general method pursued in this interesting inquiry, and we need only remark further, that in none of the experiments was a proportion of peroxide of hydrogen found exactly equivalent to the oxide of lead. But this is clearly shown to be a consequence of the rapid decomposition of the peroxide.

Schönbein has also studied the behaviour of oxygen to other metals, bismuth, nickel, cobalt, thallium, &c., and with these also has arrived at facts which support his theory of chemical polarization. In connection with these experiments he gives a new and most delicate test for peroxide of hydrogen. To water supposed to contain that body he adds one or two drops of a salt solution of one of the above-named metals, and then a few drops of potash just sufficient to precipitate the hydrated oxide of the metal. He now adds a very small quantity of solution of starch with iodide of potassium; and lastly, a drop or two of acetic or dilute sulphuric acid. If, now, the merest trace of the peroxide is present, the mixture is instantly coloured blue.

Important as Schönbein's investigations are to general chemistry, they have a far greater importance when considered in relation to physiological chemistry. The author considers that oxygen undergoes chemical polarization in the body when respired, and would thus account for the active changes which take place in the tissues. He has not yet succeeded in detecting the presence of peroxide of hydrogen in the blood, but he has shown that blood corpuscles instantly decompose the compound. He has, however, found it in urine, and explains by its presence the rapid oxidization of that fluid. Altogether these researches of Schönbein must be regarded as some of the most important on which chemists are engaged.

Since the above was printed we have seen it announced that Schönbein has succeeded in isolating both ozone and antozone, the two bodies of which ordinary oxygen is composed. Antozone has a density less than that of hydrogen, and therefore is the lightest body known. It liquifies at a pressure of 150 atmospheres. The two gases combine with explosion when exposed to the dark rays of the spectrum, and ordinary oxygen is reconstituted. This decomposition of a gaseous element must be regarded as one of the greatest chemical discoveries ever made, and we impatiently wait for a confirmation of the statement.

Sulphur is a body credited with several allotropic modifications, which, however, seem rather to affect its physical condition than its chemical properties, but the latter are to some extent changed. Thus Dietzenbacher has recently shown that by fusing only $\frac{1}{100}$th part of iodine with sulphur, the mass, after cooling, remains soft and plastic, and moreover has become insoluble in sulphide of carbon. More recently the same author, in conjunction with M. Moutier, has discovered* that many organic substances also possess the same power of modifying the condition of sulphur. Naphthaline, camphor, creosote, oil of turpentine, and even carbon alone, render it soft and plastic, and partially insoluble in sulphide of carbon. Wax and oil also render it soft, but

* 'Comptes Rendus,' t. lx. p. 353.

the solubility is not affected by these agents. The authors seem to regard this power of carbon, and bodies rich in carbon, to alter the physical and chemical properties of sulphur, as to some extent comparable to the effect of carbon in the conversion of iron into steel.

One practical result of these investigations has been to show the possibility of making large plates of sulphur for electrical machines which will be unaffected by moisture and atmospheric influences.

The mention of bisulphide of carbon recalls to our mind that Mr. Lewis Thompson has lately made public* a simple method of removing this pernicious ingredient from gas. He takes advantage of the fact that the vapour of bisulphide of carbon, and the vapour of water cannot exist together at a high temperature without undergoing a double decomposition resulting in the formation of sulphuretted hydrogen and carbonic acid. He therefore proposes to mix the gas as soon as it leaves the hydraulic main with a certain amount of steam, and to send the mixture through tubes heated to redness, in which the decomposition will take place. The resulting compounds, as probably all our readers know, are common ingredients in raw gas, and will be removed by the ordinary methods of purification. How this process will answer on the scale of manufacture common in our large gas-works we cannot say; but seeing the objectionable effects which are produced by the sulphurous acid generated in the combustion of sulphide of carbon, and probably other sulphuretted compounds in gas, the process deserves a serious trial.

Deville continues his valuable researches on the phenomena of *dissociation*, and has now invented an ingenious apparatus by which the partial decomposition of bodies below the temperature of complete decomposition can be satisfactorily demonstrated. This apparatus† consists of a porcelain tube, which carries within it a copper tube of smaller diameter. The tube being disposed in a convenient furnace, the gas to be experimented upon is passed through the porcelain tube, and at the same time a current of cold water is sent through the copper tube. The diminished temperature in the neighbourhood of the inner tube prevents the recombination of the separated components, and by certain arrangements the facts of the dissociation are clearly shown. Thus, in the case of carbonic oxide free carbon is deposited on the surface of the inner tube, while carbonic acid is found in the escaping gas. Sulphurous acid is dissociated into sulphur and oxygen, which latter unites with the excess of sulphurous acid to form sulphuric acid. In order to show this, Deville coats the surface of the copper tube with silver, which becomes blackened by the sulphur, while the sulphuric acid may be washed from the surface, and detected by means of baryta. The dissociation of hydrochloric acid is shown as clearly by amalgamating the silvered surface of the tube. By this means chlorine is fixed as chloride of silver and mercury, while free hydrogen is found in the gas which escapes.

The author does not appear to have experimented in the above way with carbonic acid and ammonia; but he states the results

* 'Newton's Journal of Arts,' Feb. 1865.

† 'Comptes Rendus,' Nov. 28, 1864.

arrived at with the induction spark. Carbonic acid is completely decomposed by the induction spark when a piece of phosphorus is placed on the surface of the mercury in the eudiometer tube to absorb the oxygen set free. After passing the sparks for twenty-four hours, only an equal volume of carbonic oxide was left.

Deville also points out that although a volume of ammonia is doubled by the action of the sparks, the decomposition is never complete. Notwithstanding that no absorption is shown when water is introduced into the eudiometer, a few bubbles of hydrocloric acid passed in, determine the deposition of chloride of ammonium, and the mercury instantly rises.

Messrs. Buckton and Odling have made an important discovery in some organo-compounds of aluminium.* They have formed aluminium ethide and methide. Apart from the importance of these compounds in determining the atomic weight of aluminium, they possess great interest in themselves. They are both colourless, mobile liquids, which take fire spontaneously in the air, burning with a smoky flame, which, along with the carbon, produces abundant flocculi of alumina. In water the ethide decomposes with explosive violence. The determinations of the vapour densities of these bodies have led the authors to the adoption of the formulæ Al Et_3 and Al Me_3, which agrees with the high atomic weight required by the specific heat of aluminium. It must be added that the vapour density of aluminium methide, like that of aluminic chloride, appears to be anomalous.

Professor Williamson, in a communication to the Royal Society,† has since shown strong reasons for still adhering to the low atomic weight of aluminium.

In connection with organic chemistry, we may mention that Dr. Hofmann has contributed‡ further researches on the colouring-matters derived from coal-tar, which we must now cease to speak of as aniline colours since the author and Mr. Nicholson have shown that toluidine is an essential constituent. These researches, while conclusive against the views of M. Schiff, still leave the exact constitution of the colours a matter of conjecture.

In advanced organic chemistry we need hardly say that incessant and rapid progress continues to be made, the discovery of new bodies almost exceeding the ingenuity of the discoverers to find names for them. From these discoveries we gain daily a clearer insight into the constitution of chemical compounds; but at present it is impossible to convey to general readers an idea of the facts revealed.

Plants containing theine have been so universally adopted as articles of diet, that man would seem to have been guided to their use by a sort of instinct. Physiologists may dispute about the use and the evils or benefits which result from it, but it is a fact that everywhere man, civilized and uncivilized, seems to exhibit a craving for substances that contain it. The medicinal effects of pure theine have as yet been but imperfectly ascertained, and we may regard it as fortunate that a new

* 'Transactions of Royal Society,' v. xiv. p. 19.
† 'Transactions of Royal Society,' xiv. p. 74.
‡ 'Transactions of Royal Society,' v. xiii. p. 485.

and prolific source of the body has been discovered in a substance which seems to be hardly available as an article of diet. The negroes of Soudan and tropical West Africa hold in high esteem the seeds of *cola acuminata*, known as the Guru-Nut of Soudan, or Kola-Nut of West Africa. In these Drs. J. Daniell and Attfield have discovered that theine exists in almost as large a proportion as in tea. As, however, the taste of the nuts seems to be unpleasant to European palates, and no mode of preparation is yet known to make it agreeable, they do not seem to be suited for an article of diet. We content ourselves, therefore, with pointing them out as a new source of theine.

Proceedings of the Chemical Society.

Since the publication of our last notice, the Chemical Society has been engaged for the greater part of two evenings in discussing Chemical Nomenclature and Notation. The subject was introduced by Professor Williamson, who, being engaged on a new elementary work, is ambitious of introducing a more precise and satisfactory system than that which is at present current. It would be impossible to convey to our readers, in the short space we can devote to the subject, an adequate idea of the Professor's views—hardly elaborated with sufficient distinctness, in the communication read—and we therefore wait the publication of the work in which we shall find the system he proposes applied. In the meantime, it was eminently unsatisfactory to find from the discussion, in which all our leading teachers joined, that chemists are by no means agreed upon the fundamental principles which must guide us in the adoption of a perfect system of nomenclature. Sir B. Brodie, indeed, seems to be of opinion that chemistry has reached a stage in which it will be found convenient to abolish the use of names altogether, and to describe things by formulæ alone.

Some laboratory memoranda communicated by Mr. R. Warington, jun., contained practical information of much interest. The colour-changes produced by the reaction of ferricyanide of potassium on ferric salts are variously described in Manuals of Chemistry, some asserting that dark or reddish brown fluid is produced, while others state that the liquid is greenish or dark-green. The author showed that these different appearances are produced by varying the proportions of the reacting compounds. Thus, the dark-brown liquid is produced when the ferricyanide is in excess of the ferric salt; and when the proportions are reversed the green colour results. With regard to the question of a precipitate, it was shown that when sufficiently acid the liquid remained clear; but with basic ferric salts a pale-brown precipitate is thrown down by ferricyanide of potassium.

Another memorandum on the solubility of magnesia in alkaline salts, showed that magnesia is to some extent soluble in salts of potassium and sodium, as well as of ammonium, though to a far smaller degree.

The most interesting meeting of the season, has been on the occasion of a discourse by Dr. Hofmann, on Lecture Experiments. There are several unquestioned facts in chemistry which must in general be taken for granted, since their experimental demonstration

before an audience is attended with many difficulties. One of these is the fact, that hydrochloric acid is composed of equal volumes of hydrogen and chlorine. By the electrolysis of hydrochloric acid as usually effected, equal volumes are never obtained; and the synthesis of equal volumes by the electric spark is never complete. Dr. Hofmann, however, showed methods of accomplishing both the analysis and synthesis of hydrochloric acid, and satisfactorily demonstrated that two volumes of the constituents produce exactly two volumes of the compound.

The lecturer next performed an experiment designed to demonstrate the fact, that two volumes of hydrogen and one volume of oxygen, combine to produce two volumes of aqueous vapour. To show this, the tube containing the mixed gases is enclosed in another tube, through which a current of the vapour of boiling amylic alcohol is maintained. The temperature of the mixed gases is thus kept at about 130° C. On passing the electric spark explosion ensues as usual, but the water formed is necessarily retained in a state of vapour, and on opening the tube under mercury it is seen that the compound resulting from the explosion only occupies two-thirds of the bulk of its constituents.*

The constitution of ammonia by volume was next illustrated, as usual, by means of the induction spark. It was shown that by the passage of the sparks the gas was resolved into constituents which occupy twice the volume of the compound. But the most striking experiment exhibited was that which showed the exact bulk of the nitrogen present in ammonia. A long tube marked into three divisions, by India-rubber rings, was filled with chlorine, and to the open end was adapted a small globe containing strong ammonia. On allowing a few drops of the liquid to enter the tube, a flash of light was observed; more ammonia was then admitted, and the tube was warmed to complete the decomposition. A little dilute sulphuric acid was then introduced to remove excess of ammonia; and now the tube being opened in communication with the same liquid, it became filled to the extent of two-thirds, leaving one-third full of pure nitrogen. Since it had been shown in a previous experiment that chlorine always unites with a volume of hydrogen equal to its own, the last experiment proved that in ammonia three volumes of hydrogen are united with one volume of nitrogen.

The only typical compound remaining, the volume composition of which requires demonstration, is marsh gas; at present, however, we have no means of experimentally illustrating the composition of this body.

Another paper, of much interest, was by Mr. Broughton, describing a new reaction for the production of anhydrides and ethers. The ready decomposition of sulphide of carbon, at a high temperature by metallic oxides, and even by water, with, in the latter case, the production of carbonic anhydride, led the author to think that by the action of sulphide of carbon on organic metallic salts, a sulphide of the

* It is right to say that this beautiful experiment, which was not completely successful before the Chemical Society, Dr. Hofmann repeated with most perfect success in one of his recent lectures at the Royal Institution.

metal would be formed and the anhydride set free. The supposition was confirmed by experiment. Acetate of lead heated with the sulphide yielded acetic anhydride. The principle of the reaction is also applicable to the formation of compound ethers, since it allows the anhydride in a nascent state to react on an alcohol. Mr. Broughton prepared acetate of phenyl, by making bisulphide of carbon react on the corresponding lead salt in the presence of phenylic alcohol. It would seem possible also to effect the isolation of anhydrides of electro-positive radicals, or ethers, by taking advantage of the abovementioned general reaction, and the author has commenced experiments with the view of eliminating phenylic ether from phenate of lead. For a more precise account of these interesting experiments, we must refer the reader to the 'Journal of the Chemical Society,' for January.

Another paper of more technical interest was by Mr. J. Spiller, on the Oxidation of India-rubber. The article of commerce known as Patent Waterproof Felt, is found to undergo in the course of time a remarkable change. It loses its strength, close texture, and waterproof qualities, and becomes hard and inelastic. This led the author to make a chemical examination of the new as well as the altered fabric. From the former benzol extracted perfectly pure and elastic India-rubber; but the solution from the latter yielded only a resinous, brittle, brownish-yellow substance, resembling shell-lac. The properties of this resin differ considerably from those of India-rubber. It is freely soluble in warm alcohol, in wood spirit, in chloroform, and in benzol; but is not appreciably soluble in ether, in bisulphide of carbon, or in oil of turpentine. Alkalies dissolve it with ease, and it is precipitated from such solutions on the addition of an acid. Like India-rubber it is bleached when immersed in strong ammonia. It fuses at a low temperature, and when strongly heated gives off an empyreumatic oil and water. When dry it is extremely brittle and highly electric. It can only be regarded as oxidation product of India-rubber formed by the absorption of atmospheric oxygen in much the same manner as resins are formed from essential oils and other hydrocarbons; and it was further remarked, that gutta percha and caoutchouc seem both to furnish the same product by the absorption of oxygen. In the course of a short discussion on the subject, Mr. De la Rue observed that the material which had undergone the change described, contained no sulphur; he had had, however, in his possession for eighteen years, samples of a similar material, containing sulphur, which had undergone no change.

An account of some Brine Springs in Nova Scotia, by Professor How, introduced a short discussion on the mode of stating the results of a water analysis, in the course of which Professor Williamson observed that it was not always correct to follow the directions of Fresenius, and combine the strongest acids with the strongest bases. A truer method would probably be to place every acid in part combination with every base, but such an arrangement would be practically impossible.

Several papers of much interest to advanced chemists have, as

usual, been contributed to the Society's Proceedings, but of these we give only the titles. "On the Action of Ammonia on Sulpho-chloride of Phosphorus," by Dr. J. H. Gladstone and Mr. Holmes; "On the Artificial Formation of Pyridine," by Mr. Perkin; "A Note on the Action of Chloropicrin and Chloroform on Acetate of Potash," by Mr. H. Bassett.

V. ENTOMOLOGY.

(*The Entomological Society of London.*)

It is usually our custom to include an account of the progress made in any section of Natural History in one of the Chronicles devoted to that branch of Science; but a special reference to the state of Entomological Science is rendered necessary by the Report recently issued by the parent Society in London.

Entomology is not thriving. It has lost some of its most ardent votaries, and there are no doubt many of our readers for whom it will suffice to mention the names of two of its disciples who have passed away, William Kirby and William Spence, to awaken in them a fresh enthusiasm for their favourite pursuit, and to remind them how needful it is that the labours of those veterans should not be permitted to eclipse the present and future contributions to Entomology.

We have before us at this time a note, written in a clear and firm hand, received from Mr. Spence in December, 1858, concluding with the announcement that "the whole of the 7th thousand of our book" (Kirby and Spence's Entomology) "are sold, and five hundred of the 8th thousand." The same note contains references to "what has been doing in Entomology this year," and gives us a vivid picture of the brave old man, who, to the close of his life, was so devoted and liberal a supporter of his science.

Without wishing to charge the living generation of Entomologists with apathy, we cannot help feeling that when those two stars waned, a shade passed over the science, which the united labours of Stainton, Newman, Westwood, Bates, Blackwall, Dallas, Lubbock, and others equally famed, have not succeeded in dispelling.

Mr. Pascoe, the President of the Entomological Society, has placed before the votaries and students of his branch of Natural History an address* containing a concise account of its present position and future prospects, and it affords us great satisfaction to give it a wider publicity, for it is well worthy of the attention of all scientific men, and merits a hearty response from all the lovers of Natural History. Mr. Pascoe tells the members of the Society that he cannot congratulate them on an increase of their funds, and that although their library is increasing in value, and the Transactions (which are sold at half-price to town members, and delivered *free* to country members) have never been so important as now, their sale is

* The Address of the President of the Entomological Society of London, 1865.

very limited; and on turning to the account of the treasurer, we are sorry to find that the outlay for this object considerably exceeds the income from the same source, and also that the amount of guinea subscriptions for the year 1864 is only 101*l.* 17*s.*, there being but ninety-seven members.

This is not as it should be. We know many unimportant provincial societies numbering half-a-dozen times as many members, and with revenues in proportion. Surely the Entomologists (and indeed the Zoologists) of Great Britain will not allow this report of the state of the parent Society to be repeated. At the conclusion of this brief notice, we append a circular that has just been issued by the Society; but let not our readers go away with the impression that the Society can do nothing besides making appeals. The President's address touches in a cursory, but interesting manner upon the progress of Entomology at home and abroad.

He refers to various articles which have appeared in Magazines and Reviews, mentioning, among others, that of the Rev. T. A. Marshall, "On the Sub-family Corynodinæ," in the 'Proceedings of the Linnean Society;' of Mr. Rye, "On the Staphylinidæ," in the 'Entomologists' Monthly Magazine;' of Mr. Trimen, "On the Insect Fauna of Madagascar," in the October Number of this Journal; and Mr. Murray's "Monograph of the Nitidulidæ," in the 'Linnean Transactions.'

He informs us that the trustees of the British Museum have issued "Mr. Wollaston's Catalogue of the Coleopterous Insects of the Canaries," filling six hundred pages, and accurately describing 930 species.

Mr. Blackwall's "History of the Spiders of Great Britain and Ireland" (reviewed in the October Number of this Journal) is also mentioned with commendation; and the observations of Mr. Blackwall regarding the means by which insects are enabled to adhere to smooth surfaces, are summarized. This subject is by no means settled by Mr. Blackwall, for there are difficulties in the way of the acceptance of his "viscid fluid" theory, just as great as the "vacuum" doctrine of West and others.

The researches of foreign investigators are not forgotten, and those of Baudelot on the influence of the nervous system on respiration of insects; of Claparède on the "pericardiac lacunæ" *of Lycosa;* of Mr. Walsh, of Philadelphia, on dimorphism in *Cynips*, are all briefly referred to. Our limited space prevents us from touching upon other interesting features in the address; but we cannot help noticing the curt judgment passed upon the lucubrations of the 'Times Bee-master,' with which the columns of the leading Journal were so long inundated. Uninitiated readers who waded through these will be astonished to hear them characterized as "rather a work of the imagination than a statement of facts."

The President complains of a want of simple catalogues or "lists of the published species of families, sub-families, and orders (of insects) with reference to the places where they are described, or where anything valuable concerning them is to be found," and he

suggests that the Linnean or Zoological Societies should undertake the work of publication.

We trust, however, that the following appeal just issued will be heartily responded to; and that so far as the Annulose sub-kingdom is concerned, the Entomological Society may itself be enabled to carry out the suggestions of its President.

"*The Entomological Society of London.*

"The Entomological Society of London was founded in 1833, for the purposes of forming a centre of union for British Entomologists, of amassing a Library of Entomological Books, and of publishing in its 'Transactions' papers on Entomological subjects.

"The Society is now producing the 12th volume of its Transactions. During the last year it published 560 pp. of letter-press, illustrated by 22 Plates. The inadequacy of its funds to defray the expense of printing and illustrating all the valuable contributions to Science which are offered to it, and which, from the unremunerative nature of such publications, may probably not otherwise issue from the press, induces the Council to make an appeal to the patrons of Science in general to join the Society, and thereby enable it to enlarge its present sphere of usefulness.

"The Council is extremely desirous of increasing the knowledge of the Entomology of our own country, and on that account asks more particularly for the assistance of the many Entomologists who are scattered over the United Kingdom; especially also is it anxious to devote attention to Economic Entomology, and requests therefore the support of agriculturists and horticulturists, and of all who are interested in the habits and economy of insects, and the best modes of cultivating the useful and of destroying the noxious species.

"The Council has recently offered two Prizes of the value of Five Guineas each, to be awarded at the end of the present year to the Authors of Essays or Memoirs of sufficient merit on subjects belonging to the economic department of the Science.

"The Society consists of Members (who pay an Admission Fee of Two Guineas and an Annual Contribution of One Guineas) and Subscribers (who pay the same Annual Contribution, but are exempt from any Admission Fee). Both are entitled to attend and introduce visitors at the Monthly Meetings of the Society, to use the Society's Library, and, if resident more than 15 miles from London, to receive gratuitously the 'Transactions' as they appear, thus actually obtaining an equivalent for the amount of the Subscription. Members or Subscribers residing within the above limits can purchase the Transactions at half-price.

"Papers of high scientific interest are awaiting publication, the furtherance of Science is the sole object of this appeal; and the Council trusts that it will result in a considerable increase of the Contributing Members of the Society."

The address appended to this appeal, which is signed by the President, is 12, Bedford Row, London, W.C.

VI. GEOGRAPHY.

(*Proceedings of the Royal Geographical Society.*)

A FRIEND once remarked to us on the subject of African missions, that it was necessary to cast a great deal of rough-cut but good stone into the sea before it was possible to build a mole to stand above the surrounding waters, or to raise a breakwater against the ocean waves. It is much the same with African explorations. Many a sterling, honest, scientific traveller is struck down before his work is completed, before he raises any monument to himself which stands out above the flood of ignorance and barbarism that overwhelm that land. Such an one was Dr. Baikie. He was the son of a captain in the navy, born at Kirkwall, and educated in the Grammar-school of that place, whence he proceeded to the University of Edinburgh, where he graduated in medicine. He joined an African exploring party in a medical capacity. For the last six years he has travelled independently, and has acquired much scientific information, which will probably be given to the public at some future time. He was returning to this country, and had arrived in Sierra Leone, in order to take the mail, when he was seized with dysentery and fever, which carried him off in two days. It seems almost to be doubted if the expenditure of valuable lives like this is repaid by the scanty effects of African discovery.

Of another party, that of the Dutch ladies who tried to ascend the western branch of the Nile — Madame Tinne herself, two of her maids, Dr. Steudner, and Herr Schubert, and, after an interval, Madame de Capellan — have all perished in the course of a third journey into the interior. Of their companions, however, Fraulein Alexine Tinne, Baron von Heughlin, Herr Mumzinger, and Moritz von Buermann still remain.

From Africa there is but little new. The old is still being brought over by those who are competent to appreciate the earnestness of travellers, the difficulty of travelling, and the impossibility of absolutely avoiding mistakes. Charity is a virtue not as yet cultivated by the Africans, whether of white or black skins.

M. Rolfs Gérard is returning to Europe, after a journey into the interior of Morocco, south of the Atlas range. He is anxious to set on foot a new expedition over somewhat similar ground. Dr. Livingstone proposes to visit that part of the east of Africa which lies between his own most northern point on Lake Nyassa and Burton and Spekes's southernmost part of Lake Tanganyika. He is to be assisted with 500*l.* from the Geographical Society, as much from the Foreign Office, and a private friend has contributed 1,000*l.*, to which may be added the Doctor's salary of 500*l.* a-year, as consul to the native races of Eastern Africa.

Farther south, the Government talk of annexing the district called British Kaffraria to the Cape Colony. The boundary of the province will henceforth be the river Kei, whilst the land which was previously occupied by the Cape mounted police, between the Kei and the Bashee, will in future be left to certain Kafir chiefs, who will be

under an amount of restraint and rule from Mr. Warner, the superintendent of the Tambookies in Cape Colony, who will for the future live beyond the frontiers for the purpose of regulating these barbarous chiefs, most of whom receive some salary from our Government, and are therefore partially amenable to our rule.

An account of "Madagascar and its People" has been written by Mr. Lyons M'Leod, formerly consul on the opposite coast of Mozambique. Naturally from his position the writer has been able to collect the best materials for such a work, which includes a history of the island, from its earliest discovery down to last year. The latest news from this same island is, that the queen has received our consul with cordiality, and professed a desire to remain in alliance with Queen Victoria as a means to her own well-being.

Complaints are frequently made of the antiquity of most of the maps of India. Several publishers have had good maps of India executed, but, like many other parts of the world, the frontiers of the various governments in the countries comprised under this general term have varied and extended so much of late years, that it is impossible to keep the whole world supplied with the latest information at a small cost. During the last twenty-five years the British frontier has advanced 1,000 miles, and the Russian territory is not only creeping onwards with steady strides at an almost equal rate, but the intermediate district is being traversed first by such men as M. Vámbéry, and afterwards by many English travellers, and that constant attendant of Englishmen, the red-bound Murray, is adding Central Asia to the almost world-encircling region mapped out and chalked out to be *done* by the energetic Englishman in search of excitement.

Mr. Ussher has published a very bulky and extensive work on Georgia, Kurdistan, Persia, and their neighbourhood, which throws much light on these countries. Thanks to M. Vámbéry, and others who have explored the districts bordering on his route, Central Asia will be before long as well known as Central Africa or Central Australia as exercising ground for scientific travellers. Mr. W. Gifford Palgrave, who has penetrated into previously unknown parts of Arabia, has been made Prussian consul at Bagdad.

Much attention has of late been attracted to Bhotan, and it is to be hoped that, if no other advantage accrue from the war now being waged in that territory, at least some geographical information and some good maps may result from it. The country is said to be in some parts adapted for the cultivation of tea, especially near the province of Assam. In a few years we may expect to find that it will be a matter of great doubt whether the tea we drink comes from that country which we have so long considered to have the monopoly of its growth. India already supplies a very large proportion of that which is drunk in England; and the colourless Japanese tea also finds not a few patrons. Englishmen are acquiring land in India for this purpose, and the natives are stirred up into some excitement by the demand for native tea, which is sold at a good profit, at 1*s.* 6*d.* a pound.

The district of Bhotan, or Bootan, to which we referred above, lies on the southern slope of the Himalayas, and includes some of the highest of these mountains, as, for instance, Chumulari, which is nearly 24,000 feet high. This district is 230 miles long, and 130 broad, and contains 19,000 square miles. Between the years 1772 and 1774 a slight collision took place between the Bhoteahs and the British; since that period little notice has been taken of the doings of these mountaineers, until their invasion of Assam and the subsequent maltreatment of Mr. Eden and his party. The military proceedings of the invading force at present have been confined to the taking of hill forts of some strength, defended with much courage by these mountaineers. The boundary towards the British possessions is not of a mountainous character, but rather marshy forest, such as would be called swamp* in America.

There is but little geographical news from Australia. The electric telegraph now connects all the principal colonies, running from Adelaide to Melbourne, thence through Sydney to Brisbane; and it is expected soon to reach Rockhampton, a town destined ere long to eclipse Brisbane, unless the latter makes great efforts to keep up the start it already possesses. We suppose Point Somerset and Cape York will be the next post; and when we have arrived thus far, we may hope for a fortnightly communication with the China mail before the latter reaches Calcutta. 'A History of the Discovery and Exploration of Australia' has been written by the Rev. Julian E. Tenison Woods, of the colony of Victory, a gentleman who adds innumerable letters to his name, and who has had great assistance in his work from governors of provinces, and others possessed of information on the subject on which he writes. The result is a dry but valuable account of the early history of the Continent, and of the latest discoveries in the interior. Amongst many valuable facts he mentions that Captain Flinders, in whose honour, as we mentioned in our last paper, the Australians have been so liberal in giving names of unconnected localities, received so little pecuniary liberality, and his surviving relatives have profited so little by his discoveries, that one of his nieces a short time since had to apply for an assisted passage to New South Wales. After the death of Flinders, there were no great discoverers in Australia until Sir Thomas Michell, in 1831. He was succeeded by Pyne, the present Sir George Grey of New Zealand, Leichhardt, Kennedy, the Gregorys, Austin, Babbage, Warburton, Macdouall Stuart, Burke, Wills, Walker, Landborough, McKinlay, and Howitt.

The work of one of the above travellers, Mr. Macdouall Stuart, called 'Explorations in Australia,' has been accepted by her Majesty and by the Prince of Wales, who thus ratify the name of "Alexandra Land" given by the discoverer to a portion of Northern Australia.

Several questions of topography, if not of Geography, will receive elucidation from the survey of Jerusalem and the Dead Sea, by the sappers under the command of Captain Wilson. Much has been done

* In the Western Continent the word "swamp" refers to the timber on the land, rather than the moisture of the soil itself.

by them, and as their work approaches completion more is found for them. The opportunity of having men who have had considerable experience in the trigonometrical survey of England in such localities is not to be passed over, and it is worth while expending a little additional money, which will surely be forthcoming for such an object, in procuring data from which accurate deductions may be made. Not only from religious and antiquarian motives must much interest be excited as regards such measurements, but natural science may expect some accessions of knowledge from the survey of the Valley of the Jordan and Dead Sea.

Mount Ætna, after a repose of thirty years, has commenced an eruption at some distance from its main crater. As yet but little damage has been done, but a very fertile district is threatened. Some lives have been lost through the explosion of water in the cisterns over which the lava has passed, and thus sealed before its heat has penetrated sufficiently to convert the contents into steam. The mountain gave warning of a coming eruption during a whole month beforehand, by a dense cloud of smoke which overhung it, the weather in the meantime becoming remarkably warm. The eruption, which began on the 31st of January, runs down the eastern side in three principal streams, which separate into several branches as they proceed. Amongst other points threatened is the famous chestnut-tree "of the hundred horsemen." It is rather remarkable that the neighbouring volcano of Vesuvius has also manifested disturbance about the same time. On the 9th of February a cone was raised, red-hot stones were thrown out, and shocks were produced which were felt in Naples. It is seldom that two of these safety-valves of under-ground disturbances exhibit activity at the same time. Probably, however, this disturbance at Vesuvius is only a reflex of the occurrences at Ætna, and not to be accounted a distinct eruption.

The Royal Geographical Society.

Since our last notice of the proceedings of this Society a very interesting paper has been read by Mr. J. G. Taylor, "Notes on a Visit to the Sources of the Tigris, with an Account of Ancient Remains found in their Neighbourhood." An exploration of countries so near Diarbekr and Kars scarcely promised to be a highly interesting subject, but Mr. Taylor observed two matters which have not been remarked on previously. Sir H. Rawlinson, previous to the departure of this traveller for the neighbourhood of the Upper Tigris, suggested that he should look in a certain locality for Assyrian remains, which Tiglath Pileser I. (about B.C. 1110) stated, in his records of his reign, that he had erected by the side of an inscription by a former king, who had laid waste the same country in bygone generations. Such memorials were entirely unknown to the inhabitants of the country, but, after a little perseverance on the part of Mr. Taylor, were discovered by him on the site indicated. This affords a remarkable confirmation of the truth of the interpretation put upon the cuneiform

characters of Assyria. The second interesting locality visited by Mr. Taylor was a cavern into which the Tigris plunges at a few miles from its source. It traverses about two miles under ground, and it is probable that formerly this distance may have been greater, as detached arches and masses of rock choke its passage at some distance from the tunnel, thus confirming the account of Strabo as to the extraordinary length of its passage under ground. Some of the sources of the Euphrates are within five miles of the Tigris,—here, as in many other instances, great rivers rise in adjacent localities, seldom, as in this case, to unite again near the termination of their course.

A paper was also read before the Society, which gave a description of "Lake Nor Tzai-san," near Berezoff in Siberia, near the boundaries of Russia and Chinese Tartary, written by M. A. Abramof, a resident at the former town. The lake is a fishing station of the Russians, and is visited yearly by a Chinese official, to whom a tribute of salt fish is presented.

The basins of large rivers form a subject of much more practical interest than the discovery of the source of the mightiest stream yet navigated; nevertheless the latter subject invariably attracts more attention, and has more of romance in it than a well-considered account of country drained by a really important means of communication between distant lands. A paper by Mr. Richard Temple, Chief Commissioner of the Central Provinces of India, "On the Basin of the River Mahanuddy," refers to a subject on which the writer is well able to speak from his official position, and forms, in fact, an abstract of the geographical portion of a report furnished to the Government; still, from its statistical and extremely practical character, it seems to have attracted little attention among scientific men. The district drained by this river system is very extensive, as the stream is navigable for 690 miles, thus forming a means of inland communication between a very extensive country, but unfortunately it does not open a road to the sea, since the mouth has silted up. This is the more unfortunate, as the district of Chutteesgurh, on the upper part of the river, is well adapted for the cultivation of cotton of a kind, it is said, superior to the majority of Indian produce. This climate causes it to be thus suited for growing cotton, as it has a moist atmosphere, and the copious rains keep the river at a regular height during a large portion of the year. This steady rain is induced by the hills surrounding the river valley, and thus irrigation is not required even for the sugar-cane. The corn crops are so great that of late years they have rotted in the stacks. In the upper part of the valley mangore swamps have encroached upon the old kingdom of a Rajpoot dynasty, which had its capital at Ruttunpoor. No other trees grow here, though lower down the forests are extensive, and large quantities of teak, and of a tree called the Sal-tree, are grown. This latter equals the Teak in durability and strength, but it requires several years to become thoroughly seasoned, and is consequently less valuable. Besides these elements of commercial enterprise, the valley affords both coal and iron in considerable abundance, which might be made available could the entrance of the river be opened to large vessels, which would

be possible at the expense of a little dredging, and by this means communication with the interior might be effected during the six months in the year when the water is highest. Until this is carried out it would be scarcely fair to the natives to induce them to cultivate cotton without means of getting it to European markets.

The same evening a paper was read from Dr. Bastian, a native of Bremen, on "A Visit to the Ruined Cities of Cambodia." The writer is still in that country, continuing his exploration of temples, bridges, and sculptures near *Thalesab*, or the Sweet-water Lake. He has found numerous inscriptions on the temples, and hopes in time to throw some light on the history of this country, a subject all the more interesting as the actual documents still in existence extend back but a short distance, all that were older having been consumed by fire.

During a dearth of other subjects, Captain Sherard Osborn, R.N., has excited the flagging interest of the Geographical Society by bringing before it the topic of Arctic exploration. He considers that we should not rest upon what has been done; that though the immediate object of former voyages, *viz.* the discovery of a north-west passage, has been gained, and that one problem has been solved, there are many more, though not of such commercial advantage as this was supposed to be in the days in which the idea was first started, still of vast scientific value—problems which ought to lead adventurous spirits to attempt, and scientific men to foster the attempt, to reach the North Pole. The leading difficulty anticipated was the opposition raised by many to what they might consider a dangerous and a useless employment of Government resources. This Captain Osborn met by showing that such an expedition is neither dangerous nor useless. During the period between 1818 and 1854 only two ships and 128 men had been lost out of forty-two exploring parties. In no part of the world had so large a surface been mapped out at so small a sacrifice of human life, and no expeditions were so popular among the common sailors as these northwards. The advantages to physical science accruing from well-directed observation in extreme latitudes promise to be exceedingly great. The mysteries of the Gulf-stream and the Ice-stream lie hidden in the abysses of the Arctic Ocean—if it exist; whether the Pole be surrounded by earth, ice, or water, is still unknown, and conclusive arguments in favour of each theory are put forth. The magnetic pole has been visited, and lengthy observations in its immediate neighbourhood have led to many modifications of our opinions on subjects connected with the needle, and especially have elucidated the dip. No voyage northwards has been undertaken but it has afforded some materials for starting new theories or correcting old ones. Grant, then, that an expedition is desirable, the next question is the route to be taken. Two principal ones strike the mind at once—one by Spitzbergen, between Greenland and the American islands, the other by Smith's Sound. The former is proposed by Dr. Peterman, the latter by Captain Osborn. By the former way sailing-ships have gone within 500 miles of the Pole, and Captain Parry attained, on the night of 22nd July, 1827, to a point at an interval of only 435 geographical miles from the desired point. But north of Spitzbergen

no land is known to exist—according to Dr. Peterman, an advantage; according to Captain Osborn, a drawback, inasmuch as no fixed points for depositing provision can be depended on. Greenland is known to extend 120 miles nearer the Pole than Spitzbergen, and there is every probability that it runs much farther. As far as it has yet been traced, icebergs are observed to come down the coast, a sure indication of extensive glaciers, which, like rivers, their representatives in warmer regions, demand a great extent of land in order to become large. Besides, extensive mountains were seen by Mr. Morton to the north of the Humboldt glacier and Cape Constitution. We may well conclude, then, that land runs far north, and that expeditions might safely deposit their provisions for their return portion of the 968 miles' sledging, which would be all that would be required in order to go from Cape Parry to the Pole. Much more than this has been done on many occasions by arctic voyagers. Commander M'Clintock's party in 1853 went 1,220 miles in 105 days; Commander G. Richards, 1,012 miles in 102 days; Lieutenant Mecham, 1,203 miles; Captains Richards and Sherard Osborn, 1,093 miles; Lieutenant Hamilton, 1,150 miles, with a dog-sledge and one man; in 1854 Lieutenant Mecham, 1,157 miles in only 70 days; Lieutenant Young, 1,150 miles; and Captain M'Clintock, 1,330 miles.

One great source of interest in these journeys would be the manners and customs of any races living in these distant regions. Sir John Ross discovered a tribe, named by him Arctic Highlanders, in lat. 75° 35′. They were hearty, strong, well-made men. A well-fed and well-disposed tribe is known to exist in Smith's Sound, and traces of inhabitants have been found between Humboldt Glacier and Cape Constitution, though the Esquimaux know nothing beyond the former barrier. The condition, civilization, and customs of such people must be highly interesting, and might throw much light upon the period when our ancestors were dependent on stone and bone for their implements, and when our predecessors in this land were more closely allied to tribes in the far north than they are at present.

The means to such expeditions as are required for these purposes are not to be found, according to Captain Osborn, in private enterprise. It was this which ruined Dr. Kane's * attempt. It only requires sufficient pressure to be exerted by the scientific and educated world upon the Governments to induce them to fit out for this service some of those fine vessels which now lie rotting in our dockyards. Two small screw-steamers, with 120 officers and men, would not appear as a large item amongst the 50,000 men annually voted for the Navy; and such employment as this would be better training and less expensive of life and money than small warlike preparations against Ashantee, Japan, or New Zealand.

Besides the ethnological, geographical, and physical observations referred to above, there is one of great practical value,—the measurement of an arc of the meridian in these high latitudes. The speaker

* We would remind Captain Osborn that Sir L. M'Clintock's successful voyage was not under Government patronage.

appealed, therefore, to the President of the Society to second and forward his views in this matter—an appeal which elicited a hearty response from Sir Roderick Murchison, as well as from General Sabine, the President of the Royal Society, Mr. John Lubbock, the President of the Ethnological Society, and others. Of course a subject of this kind is received with various feelings, and this paper has excited much controversy and excitement beyond the rooms of this Society.

Dr. Augustus Petermann, an Honorary Corresponding Member of the Society, has addressed a communication to Sir Roderick Murchison, from Gotha, on the subject of Captain Sherard Osborn's paper. Whilst most anxious for the prosecution of discovery towards the North Pole by British seamen, he urges very strongly the route by way of Spitzbergen, in preference to that by Smith's Sound, for eight principal reasons:—The Spitzbergen route to the North Pole is (1) the shortest from Great Britain, (2) the widest ocean route, (3) most free from ice, (4) it offers only drift ice as an impediment, and this is least in spring and autumn, (5) the sea to the north of Spitzbergen cannot be frozen over owing to great currents, (6) Sir E. Parry reached within 465 miles of the Pole in open sea, which extended far to the north of his position, (7) all facts lead to the conclusion that under the Pole is open sea and not land, but if it should be land, this would easily be crossed in sledges from a ship, whereas a land party coming to sea would be checked entirely, (8) the cost of the journey would be less. Sir E. Parry's expedition from the Thames to 82° 40′ N. (the highest point yet reached) and back was only 9,977*l.*

Dr. Peterman supports his theory that the Pole is occupied by sea rather than land by many ingenious arguments, and in this theory he is backed by the opinion of Captain Maury. He quotes the result of all antartic exploration that a barrier of some five or ten degrees of ice is found, beyond which open sea is again reached. If this theory be true, the learned doctor's idea that a screw-steamer might take a trip to the North Pole and back in two or three months might be realized, thus making the cost insignificant. It is also said that not only might much scientific knowledge be added to our stores by such an expedition, but that also a great deal of information might be acquired that would be of the utmost value to the whale fishers. Should it be found possible to endorse this statement, but little comparative difficulty might be found in starting an expedition. At present a great deal of contention is going on as to possibility of inducing the Government to forward the plans of the Society. Of course much may be said on both sides. It is evidently not the province of the Government of a great nation to expend the money of that nation in purely scientific pursuits; at the same time all that has reference to the material well-being of the people must fall within the duties of those who receive the proceeds of taxation. That the honour of England is enhanced by the discoveries of her great men is true enough, but her honour is in the hands of voluntary societies. If it can be shown that some material advantage to a large mercantile class, such as our whale fishers, will result from an ex-

pedition to the North Pole, the guardians of the public purse are not likely to exact very demonstrative arguments or inquire too closely into the probable results, and thus the skeleton of an exploring party may be furnished with vessels no longer of any great value for warfare, but the chief expense of scientific apparatus, &c., will have to be furnished by the Royal, Royal Geographical, Ethnological, and other Societies.

The subject of his former paper having excited such great attention, and created so much discussion in various publications, Captain Sherard Osborn read an abstract of Dr. Peterman's paper at the meeting on the 27th of February, and then proceeded to combat to some extent his position that the route by Spitzbergen was the better one. Admitting that under the Pole there was water, he would not admit that it was all open sea over the 150 millions of square miles as yet unexplored. This was one of the points that it was desired to get at rest; but in either case it would be much safer, and would give a much surer hope of the return of any exploring party if they had to travel principally over dry ground. The number of men in the naval service who were anxious for employment of this kind was very large, and included men of all ranks, from admirals and those who had won their renown in these regions, down to those who had their laurels yet to gain. The sum expended by the nation on the navy was great; much had been spent in building vessels of war to suit the new wants of scientific warfare, yet the results were few, and the fighting vessels might be counted on the fingers, whilst but a small share of this large sum, only one 230th part during the last ten years, was expended on the scientific departments, and out of this money had been used for a cricket ground—hardly a scientific advantage. All who have taken part in the discussion of this subject admit that the risk to the lives of the explorers is diminished to a very great extent, and that former failures ought not to be made a standard by which to judge of the future.

On the same evening, at a later discussion of the expedition to the North Pole, an ingenius but rather speculative paper was read by the Secretary, Mr. Markham, "On the Origin and Migration of the Greenland Esquimaux." The Esquimaux were stated by this gentleman to have originated in Asia; to have found their way to the Parry Islands, how or when does not appear, though in these islands their traces are very numerous, and have been found by all arctic voyagers; and finally to have arrived at the northern part of Greenland. Here they divided into two parts, one going south and driving out the Norsemen who had previous to this colonized the south of Greenland as far as Upernavik; the other journeying northwards, and from that time to this being cut off from communion with the rest of humanity. To seek these distant offshoots of the human family is the object of the proposed expedition, and an account of their habits, manners, language, and mode of life would throw much light on the early history of the world, and probably on the condition of our ancestors in the earliest ages. Another portion of Mr. Markham's paper, which contained less theory and a more solid basis of facts,

was devoted to an historical sketch of Greenland from the time it was first colonized by Norsemen emigrants from Iceland, when trees grew on the hill sides and a milder climate clothed those desolate shores with a verdure which made them attractive to many a roving Scandinavian Viking. Two districts were once colonized in this manner; but the Esquimaux came, war ensued, but little or no intercourse took place between the mother-country and its puny offspring thrust forth into a cold world; a deep sleep seems to come over Iceland, and now all the remains of this once flourishing colony, or the still more distant voyagers to Vinland farther south, are a few Runic inscriptions on the coast of Greenland and some of the seaboard of Continental America, and a saga or two carefully stored away among the most interesting relics of the Society of Northern Antiquities at Copenhagen, published, or to be published, by the learned members of that body, who have done so much towards elucidating the early history of all branches of the Scandinavian family.

VII. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

Palæontologists are now and then startled by some one proposing an interpretation of a fossil altogether at variance with that commonly current. Such views are often received with scant courtesy, and not unfrequently excite some amount of ridicule. But really earnest students of nature require little inducement to replace this sort of argument by one better calculated to establish truth and advance science, for palæontologists cannot but remember how many apparently *outré* opinions have afterwards turned out to be strictly correct. We doubt not, therefore, that the case we are about to record will receive in good time either confirmation or disproval from able hands.

A little pamphlet of 19 pages, by M. Sanno Solaro, a priest of the "Company of Jesus," has recently been published at Toulouse. It is entitled "Mémoire sur le premier bassin de *Dinotherium* découvert dans le département de la Haute-Garonne," and is illustrated by three quarto plates. In it is recorded the discovery of a number of remains of *Dinotherium* at Escanecrabe, in the said department, during the construction of a road from that place to Lilhac. Amongst them was an enormous pelvis, quarried out under the superintendence of the author himself; it measured about 6 feet across the crest of the iliac bones, was nearly complete, and evidently belonged to a huge *Dinotherium*.

Now we come to the remarkable point. At the side of the cotyloid cavity, M. Solaro discovered another, of a triangular form, containing the articular extremity of a small bone, which fitted into it. This he considers to be a portion of a marsupial bone, notwithstanding that it was articulated to the ilium instead of the anterior branch of the pubis, as in other marsupials.

The author ingeniously remarks that the head of the *Dinotherium* being so aberrant, the animal might almost be expected to possess other anomalous structures, and he suggests as an explanation of the position of the "marsupial bones," that had they been attached to the pubis the pouch would not have been large enough to receive the young, while their articulation to the iliac bones sufficiently accounts for the great lateral development of the latter.

The *Dinotherium* was considered to be allied to the Tapirs, by Cuvier; it was afterwards thought to be a Cetacean, until the discoveries of M. Lartet, when it took its place amongst the Pachyderms. Now, if M. Solaro be right, it must be considered a Pachydermatous Marsupial, approaching the *Nototherium* to some extent, but not in respect of the position of the marsupial bones. Again, if M. Solaro be right, the *Dinotherium* could not have been aquatic in its habits, for, as he remarks, its young would have been smothered in a few minutes after immersion.

The *Nototherium* was about the size of an ox; but the *Dinotherium* was as big as the largest species of elephant. It certainly requires a strong imagination to enable one to conceive the possibility of an animal of such colossal dimensions, with two huge tusks hanging from its lower jaw, carrying its young about in a pouch!

The Second Decade of Canadian Fossils, containing a Monograph of the *Graptolitidæ*, by Professor James Hall, is an important contribution to the literature of that curious group of fossils, for in addition to diagnoses of all the Canadian species, it contains a good description of their general anatomy, and a discussion on their affinities. Not long ago most palæontologists thought the latter question was at last settled in favour of the *Bryozoa*, so many high authorities having given their support to that view; and the discovery of a basal plate in certain species seemed to provide the only wanting link, namely, the presence, in some of the Graptolites of a structure known to occur in *Bryozoa* and not in *Hydrozoa*. In the introductory chapter to this decade, however, Professor James Hall, who is perhaps the most celebrated of the American palæontologists, describes *external* organs of reproduction, consisting of ovarian vesicles, situated on the stipe of the Graptolite, very much as similar organs occur on the stems of recent *Sertularidæ*. This is the second time, at least, that Professor Hall has stated his conviction of the ovarian character of these sacs, and if his opinion be well founded, the affinity of the *Graptolitidæ* to the Sertularians can no longer be contested. Professor Hall has satisfied himself that the "ovarian vesicles" were really attached to the stipe, and originated from it; he has also found young Graptolites of extremely minute proportions, and in all stages of development, "near to and in contact with the reproductive sac, and in one case there is but a hair's breadth between one of the fibres of the sac and one of the oblique processes at the base of the germ." The function of this "reproductive sac, or ovarian vesicle," therefore appears pretty certain, and consequently the Hydrozoan nature of Graptolites seems equally so.

One of the most paradoxical members of the series of sedimentary

rocks is the formation known as the St. Cassian Beds. According to all geologists who have studied their position and stratigraphical relations, they lie *above* the Muschelkalk; but their fossils partly belong to genera otherwise Palæozoic, and for the most part have a much *older* facies than those of the underlying deposit, which are, to all intents and purposes, of a Mesozoic type. It appears, however, that this character of the St. Cassian fauna has been too much taken for granted, and that the assertion of the fact by the older geologists meeting with no contradiction (perhaps because it was well founded), the anomaly has been much over-rated in value. Dr. C. Gustav Laube has recently undertaken the examination of the whole St. Cassian fauna, so that we may shortly expect to have the matter placed in a rather different light than hitherto. The first part of his work, which is entitled 'Fauna der Schichten von St. Cassian,' has just been published, and appears of great promise, for his investigations have yielded, so far, some curious results. This first instalment includes the description of the Sponges, Corals, Crinoids, and Echinoderms, comprising 115 species, of which 33, or nearly 30 per cent. (quite sufficient to change the facies of a fauna), are new. Many of the species belong to genera which have not hitherto been known in rocks older than the Jurassic, so that if the evidence of the Mollusca turns out to be on the same side there will be comparatively few anomalies to explain. One very important determination is, that the Encrinite hitherto supposed to be identical with *Encrinus liliiformis*, Schl., a Muschelkalk species, differs considerably from it, and is a new and very distinct species.

Amongst the many proofs that Geology is becoming day by day more popular as a recreative study, we may point to the large and increasing number of local Geological Societies. Very many of the larger towns can now boast of a Geological Society, and several other towns and districts have a Field Club, or Natural History Society, in which Geology either forms a separate section (as at Bristol) or else monopolizes a large share of the general attention. Some of the Societies and Field Clubs were started many years ago, and have led a very languishing life until recently, when they seemed to take "a fresh lease," as it were. We have no space to enter into a discussion of the causes of this revival of scientific energy; but shall content ourselves with briefly noticing some two or three of the best provincial Geological Societies, just mentioning by way of contrast, and on the grounds of impartiality, that we were lately assured that in a certain provincial town, of forty thousand inhabitants, there were only *two* people at all likely to take in the "Geological Magazine," or to read it for any consideration short of actual payment!

The Geological Societies of Liverpool, Glasgow, and Manchester, and the Royal Geological Society of Cornwall, are amongst the most flourishing. Perhaps that of Manchester has been the most successful, though the Royal Geological Society of Cornwall has been the longest established, and has published the most important works. The Liverpool Geological Society is comparatively of recent origin; we have just received the Abstract of the Proceedings of its Fifth Session (1863-64): it appears very creditable to the Society and the

Secretary, and it contains three very good papers—by Mr. Morton (the Secretary), Mr. Hicks (of *Paradoxides* fame), and Mr. Davies (of Oswestry). The Glasgow Geological Society publishes a similar volume, and full reports of the meetings are also sent to local newspapers; this is one of the reorganized Societies, and has at least one good feature peculiar to itself, namely, the delivery of monthly "Lectures," in addition to holding the usual ordinary meetings. We have read the Report of Dr. Machattie's Lecture, "On Metamorphism, with special reference to the chemical changes in Rocks," with a great deal of pleasure, and we cannot help thinking the Glasgow geologists remarkably fortunate, especially if the Lectures are always as good as this one. Mr. Dougall's paper, "On ancient sea-margins around Glasgow," read at the previous meeting, is certainly above the average in merit and care. The Dudley and Midland Geological Society is also of recent formation, and its "Proceedings," which we acknowledged in our last Number, will be dealt with on a future occasion along with those of other provincial societies.

The Royal Geological Society of Ireland, and the Geological Society of Edinburgh cannot properly be called provincial societies; but the last Number of the Journal of the former, then known as the Geological Society of Dublin, contains a paper which deserves special notice. This paper is by Mr. Sterry Hunt, and is "On the Chemical and Mineralogical Relations of Metamorphic Rocks." The interesting question discussed is, "Whether, in the absence of organic remains, or of stratigraphical evidence, there exists any means of determining, even approximately, the geological age of a given series of crystalline stratified rocks; in other words, whether the chemical conditions, which have presided over the formation of sedimentary rocks, have so far varied, in the course of ages, as to impress upon these rocks marked chemical and mineralogical differences." This is certainly one of the largest questions that could possibly be opened out for discussion. Are metamorphic rocks characterized by minerals as unaltered rocks are by fossils? Most people would very readily give an answer in the negative without being able to support their opinion by facts of importance. But, on the other hand, Mr. Sterry Hunt brings forward a sufficient number of facts to prove that the subject is a fair one for inquiry. No one now believes in unmeaning coincidences, though it would be difficult to prove, or even to suggest, a rational interpretation of very many of them. The author's suggestion seems, however, to promise well, and we hope that investigators will keep the problem in mind. What is meant, for instance, by the similarity of the blue crystalline Labradorite of the Upper Laurentian rocks of Canada to the similar mineral occurring in Skye, if not contemporaneity of the rocks in which they occur? Again, many serpentines in distant countries agree in containing chrome and nickel, while others, as those of the Scandinavian primitive gneiss formation, are destitute of those minerals; now there is sufficient collateral evidence to render probable the synchronism of the former group, while the latter is known to be much more ancient, so that here we seem to have a case in point. Still, it must be remembered, that isolated

cases like these, even if their meaning were more clear, are not sufficient to prove a law of such paramount importance, and as Mr. Sterry Hunt remarks, "it remains to be determined how far chemical and mineralogical differences, such as those which have been here indicated, are geological constants."

The 'Geological Magazine' has been quite as good as usual during the past quarter, having contained much that is instructive, with occasionally something amusing. Papers of sterling worth have been as abundant as before, and all the better for not being quite so technical. We may specially mention Professor Owen's description of *Anthrakerpeton crassosteum*, a new air-breathing reptile of low organization from the Coal-measures of Llantrissent, Glamorganshire; Mr. C. B. Rose's paper "On the Brick-earth of the Nar," in which he states his conviction of the approximate synchronism of that deposit with the Post-tertiary beds of the Clyde basin, and records Dr. Otto Torell's identification of several of the Nar shells with some of those found in the raised beds at Uddevalla; Mr. Seeley's paper "On the Neck-bones of a new Fossil Whale from near Ely," which the author states were derived from the Kimmeridge or the Oxford clay, although the oldest English whales hitherto known have been found in the Crag; and lastly, Mr. Handel Cossham's description of the geological structure of Kingswood Hill, in the course of which he shows that the rock mapped as Millstone-grit by the Geological Survey is merely a particular bed of sandstone (known as the "Holmes Rock") occurring in the Coal-measures, and that therefore coal exists (as he has proved by actual mining operations) where, if the Survey-maps were correct, it would be hopeless to look for it.

Two other papers come into another category—one by Sir Roderick Murchison, in which he quarrels with Sir Charles Lyell for stating that the gneiss of the north-west of Scotland and of the Hebrides has been *conjectured* to correspond with the Laurentian rocks of Canada. Sir Roderick says that he has *proved* it, not only for the Scotch gneiss but also for the old gneiss of Bavaria and Bohemia. What may be "proof" to the mind of one of these distinguished men, may conceivably, in a Science like Geology, be no more than a "conjecture" to that of the other. We know that everyone believes in his own theories. The other paper is vastly entertaining, and not a little remarkable; it is by Mr. Ruskin, and is entitled "Notes on the Shape and Structure of some parts of the Alps with reference to Denudation." It is so entirely *sui generis*, that we can scarcely hope to give an adequate idea of it, except by a reprint. However, we subjoin a few extracts, with explanations. Mr. Ruskin begins with the following odd notion:—"It is often said that controversies advance Science; I believe, on the contrary, that they retard it—that they are wholly mischievous—and that all good scientific work is done in silence, till done completely." Believing this, he at once acts contrary to his belief by becoming a partisan in the question of glacier-erosion, arguing the matter in his own peculiar way, after the manner of an exaggerated *reductio ad absurdum*. Thus: "Where would be the harm of granting it for peace sake, even in its complete expansion? There were, we

will suppose, rotatory glaciers—whirlpools of ecstatic ice, like whirling dervishes, which excavated hollows in the Alps," and so on. Again, "Gigantic glaciers in oscillation, like handsaws, severed the main ridge of the Alps," &c. Professor Ramsay and his followers do not require any such ridiculous suppositions in support of their views; and, although we are no advocate of their theory, we submit that Mr. Ruskin has not argued against it in a proper manner or a proper spirit. He should rather, on account of his own reputation, have stuck to the text with which he began; for if scientific controversy is mischievous, the burlesque of it is much more so. The following paragraph, with which we must conclude, is perhaps the most amusing in the paper. "The lakes of Maggiore, of Como, and Garda, are similar excavations by minor fury of ice-foam;—the Adriatic was excavated by the great glacier of Lombardy;—the Black Sea by the ice of Caucasus before Prometheus stole fire;—the Baltic by that of the Dovrefeldt, in the youth of Thor;—and Fleet Ditch, in the days of the 'Dunciad,' by the snows of Snow Hill. Be it all so; but when all *is* so, there still was a Snow Hill for the snows to come down."

The admission of this remarkable paper, *for the sake of catching a great name*, into a Scientific Journal, which should be most particularly anxious to look to *measures* and not to men, is an apt illustration of one of the growing evils of the day, for which, not editors, but the reading public, must be held responsible.

Palæontology has recently sustained a most serious loss by the death of Dr. Hugh Falconer, one of the greatest Palæontologists that ever lived. His death will be felt the more on account of his published works containing a mere fraction of the knowledge he possessed. Before he died, Geology and Palæontology were in a much more advanced state than they can now be said to be, for though he wrote little, he spoke frequently, and his opinion on Palæontological subjects was rightly deemed of the utmost value, partly from his knowledge, and partly from his caution. Now all this is lost to us, and much more also, especially the salutary check which the fear of his playful banter and scathing satire put upon the thoughtless tongues and hasty pens of younger men.

Proceedings of the Geological Society.

No less than five papers in the last Number of the Geological Society's 'Quarterly Journal' are devoted to the Laurentian Formation and its contents. This subject has recently acquired immense importance from the discovery of *Eozoön Canadense* in rocks of that age in Canada, so that in this chronicle we shall not be able to give any account of the other two highly interesting memoirs in the same number, namely, "On the Geology and Fossils of Jamaica," by Dr. P. Martin Duncan and Mr. G. P. Wall, and "On the Correlation of the Cretaceous Formations of the North-East of Ireland," by Mr. Ralph Tate.

The titles of the papers relating to the Laurentian Formation and its Fossils are as follows:—

1. "On the Occurrence of Organic Remains in the Laurentian Rocks of Canada." By Sir W. E. Logan.
2. "On the Structure of certain Organic Remains in the Laurentian Limestones of Canada." By Dr. J. W. Dawson.
3. "On the Structure and Affinities of *Eozoön Canadense*." By Dr. W. B. Carpenter.
4. "On the Mineralogy of certain Organic Remains from the Laurentian Rocks of Canada." By Mr. T. Sterry Hunt.
5. "On the Geological Structure of the Malvern Hills and adjacent Districts." By Dr. Harvey B. Holl.

The discovery of the *Eozoön* has been already recorded in this Journal; * a notice of the stratigraphical position and almost inconceivable antiquity of the beds in which it was found was given at the same time. Consequently, of the five papers, it will not be necessary to refer more than incidentally to Sir William Logan's, and our space will not allow us to enter very fully into the points discussed by Dr. Holl and Mr. Sterry Hunt, as the chief interest is centred in the descriptions of the structure, and the discussions on the affinities of the fossil by Dr. Dawson and Dr. Carpenter.

In place of the strictly technical descriptions of these distinguished observers, we give the following more popular digest of their remarks on the structure of *Eozoön*, in understanding which the reader will be assisted by the woodcuts on the next page.

In general appearance (*see* Fig. 1), were it not for the materials composing it, many specimens of *Eozoön* might be mistaken for gneiss, as it consists of more or less contorted laminæ, generally coarser in one direction—probably towards the surface. In Fig. 1, the white stripes represent the walls of the chambers, &c., and the dark ones the chambers themselves filled with an infiltrated magnesian silicate. In the diagram (Fig. 2), it will be seen that the walls (B, B) of the chambers (A^1, A^2) are perforated by a number of minute canals, which give them under the microscope the appearance of a fringe of acicular crystal, the canals being now filled with the same material as the chambers. As the chambers grew old a thick calcareous shield, or stony epidermis (C, C), called a "supplemental or intermediate skeleton," was sometimes formed outside the "proper wall" (B, B, just described) of the chambers. When this occurred, the next layer of chambers (A_2, A_2) was not in immediate contact with the previous one, being separated from it by the "supplemental skeleton," but at the same time connected with it by means of "stolons" (D), and a canal-system (E). The individual chambers of the *same* layer either open directly into one another (as at *a*, *a*), or communicate with one another by passages through a shelly partition (as at *b*). There was thus a free communication between the different chambers of the same layer, and between certain chambers of different layers.

* Vol. i. p. 475.

FIGS. 1–3. *Illustrating the Structure of Eozoön Canadense.**

FIG. 1.

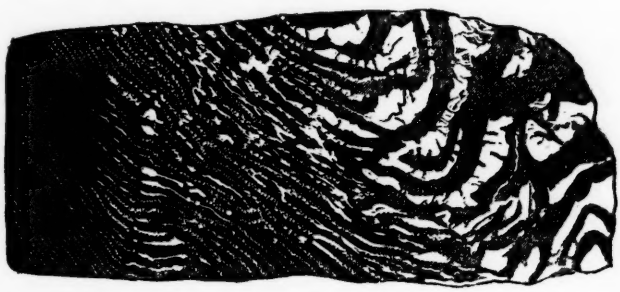


FIG. 2.

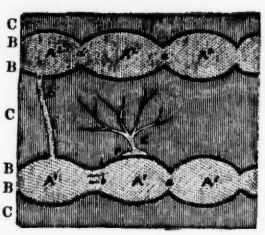


FIG. 3.

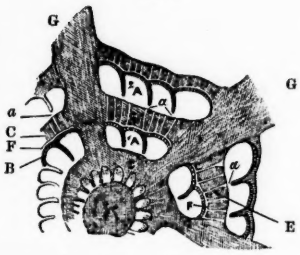


FIG. 1. Portion of a specimen of *Eozoön Canadense* from Burgess. Natural size. The white layers are dolomite; the black layers are dark-green loganite.

FIG. 2. Diagram explanatory of the structure of *Eozoön Canadense*.

A^1, A^1, A^1. Three chambers of one layer, communicating with each other directly at *a*, and by three passages through a shelly partition at *b*.

A^2, A^2, A^2. Three chambers of a more superficial layer.

B, B, B. Proper wall of the chambers, composed of finely tubular shell-substance.

C, C, C. Intermediate or supplemental skeleton, traversed by D, D, a stolon of communication between two chambers of different layers, and by E, canal-system originating in the lacunar space F.

FIG. 3. Section of the disc and radiating outgrowths (G) of *Calcarina*. The remaining letters occurring in this Figure have the same signification as in Fig. 2.

These structural features are found only in *Foraminifera*, and if we consider the *Eozoön* to belong to that class of animals, their interpretation becomes easy. The body of Foraminifera consists of the protoplasmic substance termed "sarcode;" it is soft, almost homogeneous, and remarkably plastic: it fills the chambers, is thrust through the innumerable canals in the "proper wall" of the chambers in the form of pseudopodia, and is present in all the cavities of the shell of the animal. The sarcode in the "stolons" and in the canal-system of the "supplemental skeleton" thus connects the sarcode of

* Figs. 1 and 2 have been copied from the 'Quarterly Journal of the Geological Society,' No. 81; Fig. 3 has been adapted from pl. xiv., fig. 4, of Carpenter's 'Introduction to the Study of the Foraminifera.'

the different layers of chambers, and enables the more deeply-seated portions to receive nourishment.

There appears, therefore, to be no doubt of the correctness of Dr. Dawson's determination of the Foraminiferal affinities of *Eozoön*; but we must refer to Dr. Carpenter's paper for a determination of the family of *Foraminifera* to which it is most nearly related.

Dr. Carpenter says that the structure of the "proper wall of the chambers" is so similar to that of recent and fossil Nummulites, that he finds no difficulty in placing *Eozoön* in the Nummuline series, notwithstanding its zoophytic plan of growth (*see* Fig. 1). But he observes that it presents also certain resemblances to *Calcarina*, especially in the mode in which the canal-system traversing the supplemental skeleton originates, namely, in lacunar spaces on the *outside* of the proper walls of the chambers (Fig. 2, F, and Fig. 3, F), and that it exhibits structures of minor importance, characteristic of some other genera. It should also be mentioned that, according to Dr. Dawson, the *Eozoön* probably grew in reefs, like the Corals of the present day.

We have given in Fig. 3 a diagram of the genus *Calcarina* for comparison with that of *Eozoön*, because we have found it easier to show the parallelism of the latter to recent *Foraminifera* by so doing than by giving a diagram of *Nummulina*, its nearest ally. It will be seen at once, however, that the structure of the "proper wall" of the chambers is different in *Calcarina* from what it is in *Eozoön*, and this is considered to be a more important diagnostic character than the presence or absence of a "supplemental skeleton," that structure being rather inconstant in its occurrence. Therefore, it must not be supposed that the relation of *Eozoön* is so close to *Calcarina* as to *Nummulina*, although the former appears to us better adapted than the latter for a popular comparison. In Figs. 2 and 3 we have indicated equivalent structures by the same letters, so as to render the comparison as easy as possible.

Sir William Logan contended for the organic nature of the *Eozoön* several years ago; but, as no microscopic structure could then be made out, his opinion did not receive much countenance; and when, in 1862, he brought some specimens to England, Professor Ramsay was the only English geologist who coincided with him. His energy, perseverance, and liberality under such discouraging circumstances, have excited the admiration of all, and we congratulate him most heartily on the magnificent result they have been the chief instrument in producing. The discovery of microscopic structure in specimens from another locality soon placed the matter beyond all doubt; these specimens were submitted to Dr. Dawson, and to him the credit is due of having first determined the Foraminiferal nature of the *Eozoön*. A more perfect series of specimens was finally submitted to Dr. Carpenter, who was thus enabled to corroborate Dr. Dawson's conclusions, as far as they went, and to extend very considerably our knowledge of the minute structure of the fossil. To Dr. Carpenter, also, is due the credit of determining the Nummuline affinities of *Eozoön*, and of making out clearly the exact nature and physiological meaning

of several points in its organization. Mr. Sterry Hunt, who has long argued, from mineralogical considerations, for the existence of organisms during the Laurentian period, has also done much to assist in the determination of the organic nature of *Eozoön*, and his paper on its mineralogy supplies much information on the probable mode of its preservation, and on the composition of the minerals (magnesian silicates) which have replaced the organic sarcode of the animal. These minerals, he thinks, were formed "by reactions going on at the earth's surface," and "not by subsequent metamorphism in deeply-buried sediments."

When we remember the great antiquity of the fossil, and the highly metamorphic character of the rocks in which it was found, this determination of the affinities of *Eozoön* cannot but excite our admiration, both on account of the skill with which the microscope has been made to reveal its structure, and the knowledge and patience applied to the interpretation of it, by Dr. Dawson and Dr. Carpenter; and the results more than atone for the small amount of romancing contained in their respective perorations. Dr. Carpenter's romance is perfectly harmless, and relates merely to powerful microscopes and little pins' heads; but Dr. Dawson's contains a lump of the old leaven of geological dogmatism, where it would least of all be expected. After describing an organism, perhaps as much older than the oldest Palæozoic fossil, as the latter is than the newest Tertiary, he reminds us of General Grant's "last ditch," by speculating on the probability of our having *at last* "the records of the first appearance of animal life on our planet." If the history of Geology did not furnish a sufficient number of proofs of the futility of such speculations, surely the discovery of the *Eozoön* ought to have supplied all that was wanting.

The anticipation of the authors of these papers, that their researches will form but the commencement of a long series of similar investigations, has already begun to be fulfilled, Mr. W. A. Sanford having discovered the *Eozoön* in Connemara Marble from the Binabola Mountains (*see* 'Geological Magazine,' February, p. 87). In a note to Mr. Sanford's communication, Professor T. R. Jones corroborates that gentleman's determination, and states definitely, in regard to the relationship of the Irish fossil to the Canadian, that "there is no real difference between the two."

Dr. Holl's paper "On the Malvern Hills" is an important contribution to British Geology. Its chief object is to prove that the rocks in that region hitherto termed "Syenite," &c., so far from being of igneous origin, are really metamorphosed sedimentary deposits, and that they belong to the great Pre-Cambrian or Laurentian formation. But, in addition to this principal feature, the paper is an almost complete treatise on the Geology of the Malvern Hills, and does infinite credit to its author, who has had opportunities of studying the aboriginal Laurentian rocks in their colonial home, and is, therefore, well qualified to judge of their similarity to the so-called eruptive rocks of the Malvern Hills. The arguments used by Dr. Holl in support of his chief conclusion are very strong; as an example, we quote the

following, drawn from the occurrence of a felspar with a small proportion of silica in crystalline rocks containing free quartz :—

"As this felspar occurs in rocks which contain uncombined silica in the form of quartz, as well as in those that do not, and as the ratio of its soda and lime, alumina, and silica, is as 1 : 1 : 3, nearly, we are justified, I think, in concluding that it could never have co-existed in a completely melted condition along with free silica, also in a state of fusion, or it would have entered into combination with the latter to form a felspar, like albite or orthoclase, in which the ratio is as 1 : 1 : 4; and we have thus confirmatory evidence that these rocks are not eruptive."

The Council of the Geological Society have this year awarded the Wollaston Gold Medal to Thomas Davidson, Esq., F.R.S., F.G.S., &c., for the highly important services he has rendered through many years to the science of Geology, by his critical and philosophical works on 'Fossil Brachiopoda;' and the Balance of the Proceeds of the Wollaston Donation-fund to J. W. Salter, Esq., F.G.S., &c., in recognition of his valuable services in the elucidation of Palæozoic Fossils, and to assist him in completing his Monograph of British Trilobites.

VIII. MINING, MINERALOGY, AND METALLURGY.

Mining.

It is seldom that Mining has been in so very unsatisfactory a state in this country as it is at present. From the large accumulation of stocks, the price of tin remains exceedingly low, and there are not half-a-dozen of the tin mines of Cornwall which are working with any profit. If this state of things continues, a great many must cease to work, and those which are kept in operation must be maintained at a considerable loss. The condition of things may be judged of from one or two statements lately made by the managers of important tin mines. Captain Charles Thomas, of Dolcoath mine, says—"The average price of tin credited to-day is 57*l.* 1*s.* the ton, or 5*l.* 9*s.* per ton less than the preceding six months, making a difference of 950*l.* on the whole amount credited to-day." The purser of Providence Mine remarks—"The average price of tin per ton received during the quarter was 5*l.* less than during the previous six months, or 12*l.* 10*s.* less than the average price for the last twelve years."

At Great Work, the decline has stopped all dividends, which would otherwise have been 12*l.* per share quarterly. We consider the present depression well worthy of record, since it will form a remarkable chapter in the history of our mines.

Our copper mines, too, are much depressed. The very large importations of copper from South America, from Cuba, and from Australia, interfere to a very serious extent with our own mines.

In many districts, especially in Derbyshire and at Alston Moor, the produce of our lead mines is falling off.

We have not yet been able to ascertain the produce of coal in this

country during 1864. We are informed, however, that it will be slightly less than the quantity produced in 1863. The production of iron ore has been large, and the make of iron somewhat in excess of the previous year.

Mr. Villiers announced in the House of Commons that the Bill which he intended to bring forward to make metalliferous mines ratable to the poor, would be postponed to the next Session. This had been determined on to avoid interfering in any way with an Inspection Bill, which is being prepared by the Mines Commission, and which we understand will shortly be brought into the House of Lords by the Chairman of that Commission. It is essential that some legislative measures should be brought into action for the purpose of checking the spread of carelessness which is evident in our metal mines.

From time to time, attempts have been made to use electricity as an illuminating agent in coal mines, especially in such as produced so large an amount of fire-damp as to be dangerous. As the electric arc could be maintained in vacuum, or in a vessel of water—and, as the luminous current could be instantly stopped by breaking connection with the battery,—it was thought to possess elements of safety which belong to no other method. Not one of the numerous trials which were made was successful, and the idea was abandoned. The induction coil of Rhumkorff appeared, however, to open the question anew; and, when the beautiful phenomena of electric illumination in the rarefied media of Geiseler's tubes had been witnessed, the possibility of having light without heat, and consequently of forming a perfect safety-lamp was evident.

MM. Dumas and Benoît have constructed an electric lamp, founded on the advantages presented by Rhumkorff's machine, and Geiseler's tube, and they have made some trials with the lamp in several of the French collieries, which are stated to have been successful. It will be interesting to describe this lamp. The electricity is generated by a modification of the old bichromate of potash battery, consisting simply of a zinc vessel, a porous cylinder, and a roll of carbon, charged with a solution of the bichromate of potash, and dilute sulphuric acid. This arrangement is carefully secured in a case, with a wooden cover, made to fit tightly by means of India-rubber. Next, there is a Rhumkorff's coil and condenser, placed in a stout leather case, and then the Geiseler tube, which is very slender, and for the purpose of getting the largest possible amount of surface is arranged as a conical coil. This delicate tube is enclosed in a case of thick glass, protected by a suitable metal framework. It will now be understood that the lamp consists of three parts—the battery, the coil machine, and the tube—the whole together weighing about fourteen pounds. By means of straps, this apparatus is arranged around the miner, and provisions have been made by the inventors by which he may be relieved of this weight, and the tube used at a distance from the battery and the coil.

There can be no doubt but under circumstances of extreme danger, that this lamp may be useful. An explosive atmosphere may be

entered in safety, with the advantage of having a sufficient light for examination. It must not be thought that anything approaching to the brilliancy of the electric light proper is obtainable. When the excited coil is brought in connection, by means of wires, with the Geiseler tube, into the ends of which pieces of platinum wire are hermetically sealed, it is filled with a rich phosphorescent glow, resembling in its nature the auroral light.

The weight of the apparatus,—the inconvenience which must ever arise from the use of a voltaic battery, with its two fluids,—the precautions necessary to ensure the perfect action of the induction coil,—and the delicacy of the Geiseler tube, are difficulties in the way of this lamp, which must prevent its use under the ordinary conditions of colliery labour; but there are extraordinary cases constantly arising in our "fiery" collieries, in which it may be advantageous to introduce this lamp so ingeniously arranged by Dumas and Benoît. The Institute of France has given the inventors "an encouragement" of 1,000 francs for this application of electricity, stating its advantages to be, that it afforded the means of giving succour to miners in danger of perishing from the effects of fire-damp or of the "after-damp."

M. Alphonso Dumas attended a meeting of the North of England Institute of Mining Engineers on Saturday the 4th of February, to exhibit his lamp. The light was said to cost one penny for ten working hours. The President said the inventor had no idea of his lamp superseding the Davy lamp; but merely hoped that it might be useful in places of extreme danger. Mr. Easton said the principle of a phosphoric light was not entirely new. He had heard of stale fish having been used for the purpose.

Mr. Samuel Plimsoll, a gentleman connected with the South Yorkshire coal trade and that of London, has communicated to Dr. Allen, of the Philosophical Society of Sheffield, and Mr. Peacock, the Secretary of the Coal Owners' Association, his ideas on certain plans by which he supposed the presence of carburetted hydrogen may always be visibly indicated to the miner in the galleries of any colliery. From Mr. Plimsoll's statement, which includes many subjects having but small relation to Fire Damp, we gather, that he supposes the light carburetted hydrogen of the coal mines to exist only in the upper parts of the galleries; therefore, he would have a tube open at both ends, protected from currents by boxes. In this he would place a small balloon of gold-beater's skin, filled with the lighter gas—this bag would float on the common air, but would not rise into the carburetted hydrogen—and thus he conceives there would be a regular indicator of the quantity of gas in any place where the tube might be placed. This apparatus is so simple, that there can be no difficulty in trying the experiment. We fear Mr. Plimsoll has entirely forgotten the law of the diffusion of gases, which is often very rapid in its operation; but we shall hear more of this if it proves of any value. Mr. Plimsoll proposes also the application of some chemical means to register the presence of fire-damp. We heartily desire that he may be successful in his efforts to discover a safe and easy plan for determining this question, and then direct his attention to the improvement

of the means by which the source of danger may be removed. One thing should be steadily borne in mind. Men who will tamper with a safety lamp are not to be trusted with delicate apparatus, or with observing it, if placed beyond the danger of their handling. This tube and its balloon cannot be seen without the use of a lamp, and the flame of the lamp is a far more delicate indicator of fire-damp than any other at present known.

Amongst the numerous safety-chairs exhibited at the International Exhibition of 1862, none attracted so much attention as that of Mr. J. T. Calow, of Staveley. It has been thought so highly of by practical men, that a company, 'The Patent Safety Chair Company,' is formed for bringing it into more general use.

Mineralogy.

From some interesting papers "On the Mineralogy of South America," by Mr. David Forbes, F.R.S., we take a few notes.*

Bismuth.—This metal occurs in the native state as well as in combination with oxygen, sulphur, and tellurium, in a small vein in the Lower Silurian clay slates of the mountain Illampur, in Bolivia. The mine of San Baldomero opened upon this vein, is situated but little under the line of perpetual snow, and has an elevation of between 14,000 and 15,000 feet above the level of the sea. The analysis of the native bismuth gave *Bismuth* 94·46, *Tellurium* 5·09, *Gold a trace*, *Arsenic* 0·38, *Sulphur* 0·07. The ore Bismuthine gave Bismuth 80·93, Sulphur 19·61.

Mispickel was found in the same mine, as was also *Danaite*. *Nickeliferous Mispickel* is found in a vein in the Lower Silurian slates in the Corderillas, between La Paz and Yongas, in Bolivia.

Antimonial Galena.—Of this ore considerable veins are worked near La Paz, and are worked chiefly for the amount of silver contained in them.

Gold was discovered by Mr. Forbes in several places in Bolivia; amongst others, at Ancota, Playa Gritada, Romanplaya, and the valley of Tipuani.

The composition of the specimens was as follows:—

	Tipuani.	Romanplaya.	Playagritada.	Ancota.
Gold . . .	91·96	94·189	93·51	94·73
Silver . . .	7·47	5·811	6·49	5·23
Iron . . .	Trace	..	..	0·04
Matrix . . .	0·57	..	..	..

Tin.—The discovery of metallic tin may be regarded as amongst the most curious fact recorded. It has been stated by others that tin has been found in the metallic state, but the correctness of this has been doubted. Mr. David Forbes appears to have taken every precaution to avoid being deceived, and he assures us of the discovery of a piece

* 'Philosophical Magazine,' vol. xxix., Nos. 193 and 194.

of metallic tin weighing 505 grains, at Oruro, in Bolivia. The analyses made gave the following general result:—

Tin	79·52
Lead	19·71
Copper	0·09
Iron	0·19
Arsenic	Trace
Insoluble Gangue	0·49
	100·00

M. A. Rivière has recently published a new treatise on Mineralogy, which from its completeness, we can strongly recommend to the students of this Science. He treats very fully the *Constitution of Minerals*, their *Properties, Physical and Chemical Characters*, and he gives a valuable chapter on the *Relations between the Crystalline Form and the Chemical Composition of Minerals.**

M. Marc Delafontaine communicates "Matériaux pour servir à l'Histoire des Métaux de la Cérite et de la Gadolinite," to the 'Bibliothèque Universelle.'† The more recent communication upon Terbia and Yttria enters fully into the examination of these earths by spectrum analysis, and brings forward several new and important facts. In the same manner Didymium, Erbium, and Terbium are examined, and in a note "Sur les Carbures des Métaux Yttro-Cériques," some curious chemical reactions are described.

In an ancient Celtic tomb at Mané-er-H'roek, in Lockmariaguer, in the Province of Morbihan, has been found a mineral much resembling the turquoise. This mineral had evidently been used like the turquoise, for ornament by some savage tribe once inhabiting this district. It has been examined by M. A. Damour, who finds it to consist of—

Phosphoric Acid	0·4258
Alumina	0·2957
Oxide of Iron	0·0182
Lime	0·0070
Oxide of Manganese	Traces
Water	0·2362
Silicious residue	0·0210
	1·0039

Differing as this mineral does, in the proportions of its principal constituents, and in its exterior character, from the turquoise, M. Damour proposes to distinguish it by the name of *Callais*. Many mineralogists distinguish the turquoise by the name of *Calaite*; Pliny having described a similar stone under the name of *Callais*. Damour desires to restrict the name of *turquoise* to the well-known precious stone, and

* 'Précis de Minéralogie, comprenant les Principes de cette Science; la Description des Minéraux et des Roches, leurs principaux Usages, &c.' Paris: Firmin Didot, Frères, Fils et Cie.

† 'Archives des Sciences Physiques et Naturelles.' Geneva. No. 85. January, 1865.

give that of *Callais* to this stone, which somewhat resembles it.* M. Damour supposes this mineral must have been brought from the East; but, at a more recent *séance*, M. de Mortillet has called attention to the fact that strings of nephrite, which *Callais* much resembles, are found in the mountains of Switzerland and Savoy.

M. de Hochstetter communicates to the Academy of Sciences of Vienna, an interesting paper "On the Nephrite or Jade of New Zealand."†

A new mineral of organic origin has been examined by Professor Arthur H. Church, to which he has given the name of *Tasmanite*. It was first noticed by him in the Tasmanian Court of the International Exhibition of 1862, where it was exhibited by the Dysodile Company, as a "Resiniferous Shale." In the Museum of Practical Geology is another specimen of the same mineral, labelled as "Combustible Shale, River Mersey, north side of Tasmania." Qualitative analysis of Tasmanite showed it to contain, not only a large quantity of carbon and hydrogen, but also a very considerable proportion of sulphur, and it was found that the most careful mechanical treatment of the specimens failed to separate from them completely the mineral impurities. When Tasmanite is heated in the air, it burns readily, with a very smoky flame and offensive odour; submitted to destructive distillation it fuses partially, and yields oily and solid products having a disagreeable smell, recalling that of some specimens of Canadian Petroleum. "One is tempted," writes Mr. Church, "to suggest that the natural rock-oils may in some instances originate in the action of heat upon substances similar to *Tasmanite Shale*."

The analysis of this mineral gives the following composition:—

	Experiment.	Theory C^{40} H^{62} O^2, S.
Carbon	79·34	79·21
Hydrogen	10·41	10·23
Sulphur	5·32	5·28
Oxygen	4·93	5 28
	100·00	100·00

Mr. Church, regarding the Mineral Retinite as C^{40} H^{64} O^4 compares Tasmanite C^{40} H^{62} O^2 S with it. By this it will seem that the latter differs from the former only by containing H^2 O less, and by the presence of 1 atom of S in lieu of 1 atom of O.‡

Professor Maskelyne and Dr. Viktor von Lang have contributed to the 'Philosophical Magazine' their determinations of the crystalline forms of *Malachite*, of *Gismondine*—a Zoolithic mineral in the form of small square pyramids, which occur on a basaltic lava in the neighbourhood of Rome—and of *Herschelite*. Of the latter mineral, three specimens were examined, one from Aci Reale, one from Aci Castello, and the third from Cyclops, Catania, in Sicily. Another specimen of Herschelite, from Victoria, Australia, is also the subject

* 'Annales de Chimie et de Physique,' January, 1865.
† 'L'Institut,' No. 1645, p. 398.
‡ 'Philosophical Magazine,' December, 1864, p. 465.

of some notice.* A good plate of the crystals accompanies the paper.

M. Felix Pisani presented, in December last, to the Académie des Sciences, some analyses of *Fibro-ferrite* found in the mines of Pallières, in the Département du Gard, France. The composition of this mineral, which is a variety of *Copiapite*, described by Prideaux,† was found to be—*Sulphuric Acid* 29·72, *Oxide of Iron* 33·40, *Lime traces* and water 36·88.

The same chemist and mineralogist also made an additional communication on some new minerals from Cornwall. *Langite* we have already named. *Brochantite* has hitherto been found only in Nassau, Siberia, and in Cumberland. It has now been found in Cornwall. The Cornish Brochantite exists in little crystals of the ordinary form, transparent, and of a vitreous lustre. The composition was found to be—*Sulphuric Acid*, 17·2; *Oxide of Copper*, 68·8; *Oxide of Iron and Lime*, 1·0; Lime, 0·8; and *Water*, 13·2; which gives the ordinary formula of Brochantite, $Cu^3 S^3 + 3$ aq.

Polianite, a variety of Pyrolusite, hitherto unknown in Cornwall, has been found there by M. Pisani. This is, says he, "a new locality to add to those already known of this interesting species, which I regard, with M. Breithaupt, as being the primitive *peroxide of manganese par excellence*."

M. Pisani also notices a porphyroidal granite, in which the mica is replaced by tourmaline, and which belongs to the series of tourmaliniferous granites of M. Senff. The name of *Luxulianite* is proposed for this species, "because it is found in the parish of Luxulian, near Lostwithiel, where it was first recognized by Mr. Richard Talling, to whom also is due the discovery of Langite, Brochantite, Devilline, and Polianite, in Cornwall." ‡

The analyses of several minerals found in the kingdom of Siam was communicated to the Academy of Sciences, at Paris, at the last meeting of the year 1864. These were Gold, Corundum, Oriental Emerald, Iron Ores, some Bitumens, and Clays.

M. Dumas, in the name of M. Marignac, of Geneva, communicated to the Académie des Sciences, on the 16th of January, a memoir upon the "Combinations of Niobium." The author of this memoir arrives at the conclusion that the Hyponiobium of M. Henry Rose is identical with Niobium.

M. Dove has given the Physico-Mathematical Class of the Berlin Academy of Sciences the results of an elaborate examination of the Quartz of Euba, the optical properties of which are compared with those of Carthamine and other substances, showing the phenomena of Dichroism.

M. Schröter has shown that by peculiar treatment, described by

* 'Philosophical Magazine,' vol. xxviii., No. 129, p. 502.

† *See* 'Glossary of Mineralogy,' by H. W. Bristowe, in which work, however, the locality is stated to be Chili only.

‡ 'Les Mondes,' tome vi. p. 585.

him to the Academy of Sciences of Vienna, the Lithioniferous micas will yield Lithium, Rubidium, Cæsium, and Thallium.

M. Hermann has described a new mineral found at Gumeschefsh, in the Ural, which much resembles Wavelite in its mode of occurrence and in composition. To this he has given the name of *Planérite*. Its composition is, as compared with Wavelite, as follows :—

		Wavelite.
Phosphoric Acid	33·94	33·40
Alumina	37.48	35·35
Oxide of Iron	3·52	1·25
Oxide of Copper	3·72	..
Water	20·93	26·80

Brushite.—In a sample of "rock guano" from Avis Island, in the Caribbean Sea, a new mineral has been discovered. Dr. Gideon E. Moore has carefully examined this mineral, and he gives the following as its composition :—

Lime	32·65
Phosphoric Acid	41·50
Water	26·33
	100·48

These figures, he says, agree exactly with the composition of the neutral tri-basic phosphate of lime 2 Ca O, HO, PO_5, with the addition of four equivalents of water of crystallization. The crystalline structure has been examined by Professor J. D. Dana, who thus describes the minerals—"The crystals are slender prisms, not over a third of an inch in length. The prisms are monoclinic, and are often flattened parallel to the clinodiagonal with perfect and pearly clinodiagonal cleavage." This new mineral has been named by its discoverer *Brushite*, after Professor C. J. Brush, of Yale College.*

Emery has been discovered in Chester, Hampden County, Massachusetts. It is spoken of by Dr. Charles J. Jackson as "an inexhaustible bed of the best emery in the world." It appears to have been long mistaken for an iron ore, and indeed used as such. The principal bed of emery is seen at the base of the South Mountain, where it is four feet wide. Its course is N. 20° E.S. 20° W., and its known extent is four miles. Near the summit of the mountain, the bed expands to more than 10 feet in width, and in some places is even 17 feet wide.

The analyses of two varieties—a coarsely crystalline emery of the North Mountain, Cheshire, sp. gr. 3·75 H 9, and the emery from South Hill, sp. gr. 4.02 H 9, are marked respectively 1 and 2—

	(1)	(2)
Alumina	46·51	45·50
Protoxide of Iron	44·00	43·00
Titanic Acid	5·00	11·50
Silica and loss	4·50	
	100·00	100·00

* Communicated to the California Academy of Sciences. 'Silliman's Journal,' January, 1865.

Regarding the iron which can be dissolved out, as accidental, and digesting it in acids, we have—

	(1)	(2)	Naxas best selected.
Alumina . .	60·4	59·05	62 3
Protoxide of Iron .	39·6	40·95	37·7

It is said that practical trials of the Chester emery in the large armouries and machine shops, have proved it to be fully equal in value to the well-known emery of Naxos.*

Petroleum in California.—Professor Silliman recently visited a newly-discovered petroleum region, which he thus describes in his Report:—"Ten miles north of Buenaventura, there is a mountain ridge 2,000 feet in height, extending for 13 miles from E. to W., which consists in part of bituminous shales, supposed to be either of the Cretaceous or Tertiary period. The dip of the layer is 70° to 80° to the north. From these shales, mineral oil comes out in many places, and at some points very abundantly. One of these wells is 30 feet in diameter, and is full of tar-like oil, boiling with the escape of marsh gas. There is also an area of asphaltum three-fourths of a mile long by half-a-mile wide, exuding tar and rock oil at numerous points, besides several oil springs, the places of discharge in all exceeding twenty. The range of bituminous shales occurring at intervals for a hundred and fifty miles, and also as far north as Glenroy, in Santa Clara County, or about 80 miles from San Francisco.†

Some interesting analyses of several varieties of lead ores from the mines of Pontgibaut (Puy-de-Dôme) have been made by M. Charles Mène and M. L. Courrat, of Lyons, the results of which have been communicated to the Académie des Sciences of Paris. The minerals examined were the *Sulphate of Lead* (Anglesite), *Arsenio phosphate of Chloride of Lead*, and the crystallized *Carbonate of Lead*. For the result obtained we must refer our readers to the ordinary sources through which the communications of the Academy are given to the public.‡

Metallurgy.

During the first quarter of 1865 there has been little of novelty to record. The extension of the application of machinery to puddling has been steadily going on. Mr. Menelaus, the manager of the iron works at Dowlais, appears to have been very successful in the experiments which he has made; and as soon as a new set of furnaces,—now in course of construction,—are in a fit state for use, he invites the iron-masters and managers of works to some public experiments to be then made at Dowlais.

We learn that the preliminaries for a patent have been taken by Mr. John Arthur Phillips, for a process of great simplicity, by means

* 'Silliman's Journal,' vol. xxxix. p. 87.
† 'Silliman's Journal,' vol. xxxix. p. 101.
‡ 'Les Mondes,' 6 liv. 9 February, 1865.

of which coppery lead can be rendered equal in quality, for white lead manufacture, to W. B. lead.

The French Government has published some very complete returns of the manufacture of iron in that country. These show a rapid improvement in, and a great extension of, the manufacture of iron in France.

A large volume has been published at Turin, by the Italian Government, 'On the Manufacture of Iron in Italy.' Nothing can show more strikingly than this work does, the advantages which must arise from the liberal government under which that country is now placed. The amount of information given in this book, which has been compiled and printed regardless of cost, is very great; and we particularly recommend it to the attention of all who are interested in this special industry.

The Queen of Spain is said to have determined on having a Mineralogical and Geological Survey made of that country, with an especial view to the extension of its mines and metallurgical works.

It is pleasant to hear that a similar survey is to be carried forward with all dispatch in Portugal.

Dr. Lermer, in a paper entitled "On the Chemical Resistance of Lead and its Alloys with Tin to the Vapour of Water," desires to show, that whereas pure lead is actively attacked by water vapour, the addition of tin prevents this action. With equal parts of lead and tin, the action is only 1-10th of that which takes place with pure lead, and an alloy containing 37 per cent. of lead is scarcely attacked at all.*

The effects of Wolfram upon Ordnance Castings, form the subject of an important paper, by M. Le Quen. From this it would appear that great additional toughness is communicated to iron by an admixture of wolfram.†

The cementation of iron is still a subject of eager discussion between the French manufacturers of steel and the chemists. M. Julian has lately communicated a note on this subject to the Academy. The results of experiments with graphite are said to be in complete opposition to the assertions of M. Caron, on the one side, and those of M. Fremy, on the other. We are content for the present to leave this subject without further notice, as, without doubt, the whole question will be carefully examined by other chemists.

A paper of considerable interest, on "Les Grandes Usines de France," appears in 'Les Mondes.' It notices especially the Blast furnaces, Forges and Steel works of Petin, Gaudet and Company, at Vierzon, Givors, Toga, Rive-de-Gier, St. Chamond, and Assailly; another section describes the Mines and Smelting-works of the Veille Montagne Company, Moresnet, Angleur, Bray, Tilff, Valentin-Coq, and other places. The Warm Baths of Vichy have also some notice.‡

* 'Chemisches Central-blatt,' No. 4, 1865.
† 'Annales de Chimie et de Physique,' January, 1865.
‡ 'Les Mondes,' tome vi. p. 713.

IX. PHYSICS.

LIGHT.—Light and astronomy are so nearly allied, that it is frequently a matter of difficulty to know how to apportion the subjects treated of in these Chronicles. This difficulty is more especially felt at the present time, when spectrum-analysis—a subject which has been hitherto hovering between chemistry and optics—has suddenly shot off to the sun and fixed stars, and is commencing more distant flights to the nebulæ. We have divided the subjects in this branch as well as the circumstances will admit; but the natural tendency which there has been of late years to the mutual interpenetration of all the sciences, will necessarily cause a great deal of chemistry and astronomy to come into optics, as well as astronomy and optics into chemistry. With this explanation, we will proceed to chronicle a most important service which optical science has done for her great sister astronomy —a service the more remarkable, inasmuch as astronomy, whilst she was really unable to solve the difficult question, fancied that the whole subject was a very straightforward one, and had fallen into an error which it will take perhaps the remainder of this century to eradicate from astronomical text-books. We refer to the constitution of the nebulæ. These bodies are generally divided into resolvable and irresolvable, the former being split up under more or less powerful telescopic means into bright points, which have been always considered stars, whilst the irresolvable ones have been generally regarded as being similar clusters of stars, too far off, however, to be resolved into discrete points by our present optical means. As the aperture and defining power of telescopes increased, nebulæ of the latter class have one by one been transferred to the former, until the opinion has gradually prevailed, that all nebulæ would ultimately prove to be resolvable. Although serious doubts as to the generality of such a law have been entertained by many eminent astronomers, the question would have long remained unsolved had not the services of spectrum-analysis been called into requisition.

In a paper recently presented to the Royal Society, Mr. William Huggins gave the results of the application of prismatic analysis to some of the objects in the heavens known as nebulæ. Eight of the nebulæ examined gave a spectrum indicating gaseity, and of these six belong to the class of small and comparatively bright objects, which it is convenient to distinguish still by the name of planetary. These nebulæ present little indication of probable resolvability, even with the greatest optical power which has yet been brought to bear upon them. The other two nebulæ, which gave a spectrum indicative of matter in the gaseous form, were the annular nebula in Lyra and the Dumb-bell nebula. The results of the examination of these nebulæ with telescopes of great power must probably be regarded as in favour of their consisting of clustering stars; it was therefore of importance to determine by the observation of other objects, whether any nebulæ which have been certainly resolved give a spectrum which shows the source of light to be glowing gas. With this purpose in

view, the light of two easily-resolved clusters was submitted to spectrum-analysis, but both gave a continuous spectrum.

Mr. Huggins then examined the Great Nebula in the Sword-handle of Orion.* The results of telescopic observation on this nebula seem to show, that it is suitable for observation as a crucial test of the correctness of the usually received opinion—that the resolution of a nebula into bright stellar points, is a certain and trustworthy indication that the nebula consists of discrete stars, after the order of those which are bright to us. Would the brighter portions of the nebula, adjacent to the trapezium, which have been resolved into stars, present the same spectrum as the fainter and outlying portions? In the brighter parts would the existence of closely-aggregated stars be revealed to us by a continuous spectrum, in addition to that of the true gaseous matter?

The telescope and spectrum apparatus employed were those of which a description has already been given in our Chronicles of Astronomy. When turned towards the brightest parts of the nebula near the trapezium, the light was resolved by the prisms into three bright lines in all respects similar to those of the gaseous nebulæ. These three lines appeared (when the slit of the apparatus was made narrow) very sharply defined, and free from nebulosity; the intervals between the lines were quite dark. When either of the four bright stars β, γ, δ, Trapezii, was brought upon the slit, a continuous spectrum of considerable brightness, and nearly linear (the cylindrical lens of the apparatus having been removed), was seen, together with the bright lines of the nebula, which were of considerable length, corresponding to the length of the opening of the slit. The fifth star γ', and the sixth α', are seen in the telescope, but the spectra of these are too faint for observation.

The positions in the spectra of α, β, γ, δ, Trapezii, which correspond to the positions in the spectrum of the three bright lines of the nebula, were carefully examined; but in no one of them were dark lines of absorption detected.

The part of the continuous spectra of the stars α, β, γ, near the position in the spectrum of the brightest of the bright lines of the nebula, appeared on a simultaneous comparison to be more brilliant than the line of the nebula; but in the case of γ, the difference in brightness was not great. The corresponding part of δ was perhaps fainter. In consequence of this small difference of brilliancy, the bright lines of the adjacent nebula appeared to cross the continuous spectra of γ and δ Trapezii.

Other portions of the nebula were then brought successively upon the slit; but throughout the whole of those portions of the nebula which are sufficiently bright for this method of observation the spectrum remained unchanged, and consisted of the three bright lines only. The whole of this great nebula emits light, which is therefore identical in its characters; the light from one part differs from the light of another in intensity alone. The clustering stars, of which, according to

* 'Proceedings of the Royal Society,' vol. xiv. p. 39.

Lord Rosse and Professor Bond, the brighter portions of this nebula consist, cannot be supposed to be invisible in the spectrum apparatus because of their faintness—an opinion which is probably correct of the minute and widely-separated stars seen in the Dumb-bell nebula. The evidence afforded by the largest telescopes appears to be, that the brighter parts of the nebula in Orion consist of a "mass of stars;" the whole, or the greater part of the light from this part of the nebula, must therefore be regarded as the united radiation of these numerous stellar points. Now it is this light which, when analyzed by the prism, reveals to us its gaseous source, and the bright lines indicative of gaseity are free from any trace of a continuous spectrum, such as that exhibited by all the brighter stars which have been examined.

The conclusion is obvious, that the detection in a nebula of minute closely associated points of light, which has hitherto been considered as a certain indication of stellar constitution, can no longer be accepted as a trustworthy proof that the object consists of true stars. These luminous points, in some nebulæ at least, must be regarded as themselves gaseous bodies, denser portions probably of the great nebulous mass, since they exhibit a constitution which is identical with the fainter and outlying parts which have not been resolved. These nebulæ are shown by the prism to be enormous gaseous systems; and the conjecture appears probable that their apparent permanence of general form is maintained by the continual motions of these denser portions which the telescope reveals as lucid points.

The opinions which have been entertained of the enormous distances of the nebulæ, since these have been founded upon the supposed extent of remoteness at which stars of considerable brightness would cease to be separately visible in our telescope, must now be given up, in reference at least to those of the nebulæ the matter of which has been established to be gaseous.

It is much to be desired that *proper motion* should be sought for in those of the nebulæ which are suitable for this purpose; indications of parallax might possibly be detected in some, if any nebulæ could be found that would admit of this observation. If this view of the greater nearness to us of the gaseous nebulæ be accepted, the magnitudes of the separate luminous masses which the telescope reveals as minute points, and the actual intervals existing between them, would be far less enormous than we should have to suppose them to be on the ordinary hypothesis. It is worthy of consideration, that all the nebulæ which present a gaseous spectrum exhibit the *same three bright lines;* in one case only, 18 H. IV., was a fourth line seen. If we suppose the gaseous substance of these objects to represent the "nebulous fluid" out of which, according to the hypothesis of Sir W. Herschel, stars are to be elaborated by subsidence and condensation, we should expect a gaseous spectrum in which the groups of bright lines were as numerous as the dark lines due to absorption which are found in the spectra of the stars. Moreover, if the improbable supposition be entertained, that the three bright lines indicate matter in its most elementary forms, still we should expect to find in some of the nebulæ, or in some parts of them, a more advanced state towards

the formation of a number of separate bodies, such as exist in our sun and in the stars; and such an advance in the process of formation into stars would have been indicated by a more complex spectrum.

It is a point of some interest at present to know whether certain lines in the solar spectrum are due to the sun or to the earth—that is, whether they are due to the absorption of rays by the solar or the terrestrial atmosphere. Knowing this, we should be enabled to ascertain whether special bands which are seen in the spectra of the planets, Jupiter especially, were due to their atmospheres. Father Secchi* has lately communicated the results of some very accurate measurements which he has made upon these bands with the object of learning to what they were due. The solar rays and that of sodium served as the starting-point for the measurements. The atmospheric rays were determined by observing the air near the horizon. The moon was also sometimes made use of when it was a little above the horizon. Great care was taken each time to fix the micrometric slit upon one of the strongest atmospheric rays, to see if they coincided or not with those of Jupiter. In the interval between the observations the instrument was left untouched, although it was subsequently observed that this precaution was superfluous. The various bands were not equally easy to measure, for some are more diffused on one side than the other; and that of the dark red is difficult, especially if the air is at all impure. The results show that the bands of Jupiter do not agree at all with those of our atmosphere, whilst some are quite wanting. The general results do not disprove the existence of solar rays in the planet, but show that its atmosphere has a strong absorbing power, and a different one from ours.

At the meeting of the Manchester Literary and Philosophical Society, on January 10, Dr. Roscoe exhibited some very interesting photographs of the fixed lines in the solar spectrum made by Mr. Rutherford, of New York. These photographs exhibit groups of thousands of lines, extending from near the line *b* in the green, to beyond H in the violet, and serve as a most valuable confirmation of the accuracy of Kirchhoff's maps. Each line in these maps can be easily and distinctly traced in the photograph, whilst many bands drawn as single ones by Kirchhoff are seen in the magnified photograph to consist of bundles of fine lines. These photographs were prepared with three 60° bisulphide of carbon prisms.

A new spectroscope, in which the great desideratum of direct vision is obtained, has lately been made by the well-known optician, Browning, from designs furnished him by A. Herschel, Esq. The principle is as follows:—What is called a 3 to 1 right-angled prism, in which the hypotenuse is three times as long as the base, is placed in the path of a ray of light in such a manner that the ray falling at an angle of 45° on the shortest side of the prism, is refracted, then twice reflected totally, when it emerges at an angle of 45° from the prism, but in the same direction as when it entered. The light is *dispersed* both at its entrance and at its emergence; but owing to the *two* reflec-

* 'Phil. Mag.,' vol. xxviii. p 486.

tions which it has suffered, the dispersion, at its exit, is added to the dispersion at its entrance instead of being subtracted from it, as would have been the case had only one reflection taken place. The instruments are made with two such prisms connected together by their like ends; the combination producing a direct vision spectroscope, of which the dispersive power is four times greater than that of any single surface of the prisms. With a magnifying power of 5 only, Fraünhofer's line D is appreciably separated, whilst the other dark lines are seen with much distinctness and in great numbers. The slit is fixed on a slider, by means of which arrangement any part of the spectrum may be brought into the field of view.

It is to be hoped that some information will soon be obtained respecting the composition of meteors from the colours which they assume. Data for such theoretical discussions are being gradually accumulated. Mr. Schmidt has recently communicated to the Belgian Academy some observations made at Athens on the colours of shooting stars; he finds that red and green coloured meteors are most often seen in summer. The author has noted the colour of 5,671 meteors; 4,300 of these were white, 905 yellow, 320 red, and 146 green.

With one useful application of light to the requirements of everyday life we will conclude our chronicles of this branch of science. In some parts of Paris some very successful attempts have been made to render the names of the streets as visible at night as in the day time. In the neighbourhood of the Hôtel de Ville, the names are now lighted up in the following manner:—the frame in which the letters are set is made in the form of a rectangular trough, the upper and lower portions being pierced with holes to allow of proper ventilation, and within this is a gas pipe with a number of small jets, according to the length of the tablet; in front of these jets are arranged the transparent letters which are thus brightly illuminated. The upper part of the box or trough opens to allow of lighting and repairs, and is closed by a counterpoise concealed in the stone work of the walls.

Heat.—Professor Tyndall has communicated to the Royal Society the results of his important researches on the invisible heat radiation of the electric light. The distribution of heat in the spectrum of the electric light was examined by means of a linear thermo-electric pile. The electric spectrum was formed by lenses and prisms of pure rock-salt, its width being equal to the length of the row of elements forming the pile. The latter standing at right angles to the length of the spectrum was caused to pass through its various colours in succession, and to search the spaces beyond the region of colour in both directions. As in the case of the solar spectrum the heat was found to augment from the violet to the red, while the maximum heating effect was observed beyond the red. The augmentation of temperature beyond the red in the case of the electric light is sudden and enormous, being much greater than that obtained by Professor Müller for the solar spectrum. Aqueous vapour acts powerfully upon the invisible rays, and doubtless the action of this substance in our atmosphere has modified the intensity of the rays beyond the red. In the experiments

now to be referred to, the rays from the electric light were converged by a small concave glass mirror silvered at the back. It was brought so near the electric light as to cast an image of the coal points five or six inches in advance of the light. A solution of iodine in bisulphide of carbon contained in a rock-salt cell was then placed in front of the lamp; the whole of the luminous rays were thereby cut off, the dark heat rays only coming to a focus.

In this focus of intense heat, in which nothing whatever is visible to the sight, what will take place if a solid body is introduced? Will the body become red or white hot; that is to say, will the long vibrations of the heat rays be exalted in refrangibility and vibrate in a quicker period? We know that rays can be lowered in refrangibility, but the possibility of rays of low refrangibility being raised higher has been denied by some physicists on theoretical grounds. The experiments of Professor Tyndall have conclusively settled the question, and proved that rays can be transmitted upwards, as well as downwards.

With an eight-inch mirror behind the electric light, the opaque solution of iodine in front, and the focus of invisible rays about six inches distant from the electric light, the following effects have been obtained:—Wood painted black, when brought into the dark focus, emits copious volumes of smoke, and is soon kindled at the two spots on which the images of the two coal points fall. A piece of brown paper placed near the focus soon shows a burning surface which spreads over a considerable space, the paper finally bursting into flame. The end of a cigar placed at the dark focus is instantly ignited. A piece of charcoal suspended in a receiver of oxygen is ignited in the dark focus and caused to burn brilliantly. A mixture of oxygen and hydrogen is exploded in the dark focus by the ignition of its envelope. Magnesium wire presented suitably to the focus, burns with its intensely luminous flame. In all these cases the effect was due in part to chemical action; this, however, may be excluded. For instance, platinized platinum in thin leaf may be rendered white hot, and on it is depicted an incandescent image of the coal points. When the points are drawn apart or caused to approach each other, their incandescent images conform to their motion. Professor Tyndall proposes that the assemblage of phenomena here described, and others to be referred to in his completed memoirs, should be expressed by the term "calorescence." This word involves no hypothesis, and it harmonizes well with the term fluorescence, now universally employed with reference to the more refrangible end of the spectrum.

The subject of dissociation of the elements of compound gases at high temperature is being energetically worked out by H. Ste. Claire Deville.* He has previously shown that both water and carbonic acid possess the apparently paradoxical property of partially resolving themselves into their elements when heated to a much lower point than that attained by the combination of the elements of which they are composed. The great difficulty in experiments of this kind is to prevent the decomposition from being immediately followed by a re-

* 'Chemical News,' vol. x. p. 285, and vol. xi. p. 2-90.

combination of the separated elements; this can only be effected by causing these elements to come in contact with a relatively very cold atmosphere. By a modification of his apparatus, M. Deville has succeeded in effecting the dissociation of carbonic oxide, sulphurous, hydrochloric, and carbonic acids, and ammonia. He passes through a furnace a porcelain tube, with corks at each end, through which is introduced a small brass tube. In the space between the porcelain and the brass tube, a current of the gas under experiment is allowed to flow by means of glass tubes passing through the corks. A rapid current of water is constantly passing through the brass tube, which is thereby kept cold, whilst the porcelain tube can be raised to a white heat. The apparatus being thus arranged, a current of pure dry carbonic oxide is passed through the porcelain tube, and as it issues out it is conducted into baryta water, by means of which the presence of carbonic acid may be shown. As soon as the porcelain tube attains a red heat, the carbonic oxide is decomposed into oxygen (which burns a further quantity of carbonic oxide into carbonic acid), and carbon, which attaches itself in the form of lamp-black to the brass tube traversing the porcelain tube.

We have thus in a very small space a greatly heated cylindrical porcelain surface, and a very cold brass surface. The molecules of carbonic oxide heated in the porcelain tube, after having been partially decomposed into oxygen and carbon, encounter the cold side of the brass tube, when the particles of carbon mechanically attach themselves to it. Here being cooled by the water circulating in the metal tube, the carbon escapes the action of the oxygen or carbonic acid. The brass tube is, in fact, found to be blackened by the carbon when the apparatus is carefully taken to pieces, and its quantity is in proportion to the quantity of carbonic acid contained in the escaping gas. In the experiment with sulphurous acid, the inner metallic tube which carries the stream of cold water was silvered on its external surface. After the current of sulphurous acid had continued for some hours, the silver surface was found to be blackened or sulphuretted, and at the same time covered with a layer of anhydrous sulphuric acid, showing that sulphurous acid had been dissociated or completely decomposed into sulphur, which was deposited on to the silver and oxygen which combined with the excess of the acid to form sulphuric acid. Until now sulphurous acid has been considered completely undecomposable by heat. In the experiment with hydrochloric acid, the author amalgamated the silvered surface of the cold tube with a very small amount of mercury, and so obtained a very brilliant surface. After pure hydrochloric acid gas had passed for some hours, this surface was found covered with chloride, and by a peculiar arrangement M. Deville was able to collect some hydrogen. Carbonic acid and ammonia were decomposed with the induction spark.

A very ingenious maximum thermometer has been described by Mr. Twining.* It is a spirit thermometer, having about one-third of the way up the tube a small bulbous enlargement, in which is lodged

* 'Chemical News,' vol. xi. p. 29.

a globule of mercury, which serves as an indicator. As long as the spirit rises, this globule remains stationary; but as soon as the spirit descends, the mercury sinks likewise, lengthening into a small cylinder, about 1-10th or 1-12th of an inch long, which cuts in two the column of alcohol. It is evident that on adding to the degrees marked by the extremity of the spirit-column, those shown by the inferior extremity of the indicator on the lower scale, we ascertained at once the maximum of heat to which the apparatus has been exposed. Upon warming the bulb of the instrument with the hand till the mercury reaches the enlargement, and then placing the instrument flat while the spirit cools, the thermometer is ready for another observation. The advantages of an instrument of this kind are—1, it is available for taking observations where only an upright thermometer can be used; 2, it is not affected by travelling; and 3, it is very easy to make.

The use of petroleum as steam fuel in place of coal, is attracting considerable attention. Mr. C. J. Richardson is conducting experiments at Woolwich Dockyard, with the view to test the capability of petroleum to supersede coal and other fuel on board ship. Dr. Paul has published some calculations, in which he attempts to prove that the proposed application of it is based upon erroneous impressions respecting the composition and character of petroleum as compared with coal. He starts with the statement that the oil can be so utilized that one ton is equal for steam purposes to five tons of coal. Now, the specific gravity of coal being about 1·44, whilst that of petroleum is from 0·80 to 0·85, the weight of a cubic foot of these materials would be respectively—coal 90lbs., and petroleum 50lbs to 53lbs. But since petroleum, being liquid, lies in a more compact manner than coal, in estimating the spaces occupied by these materials an allowance of one-third should be made for the interstices or empty spaces between the lumps of coal; so that the spaces occupied by equal weights of coal and petroleum are about as 1 is to 1·2 or 1·4. Then the relative heating-power of equal weights of coal and petroleum, depending upon their respective chemical composition, are in the following ratio:—Calorific power—coal, 1·02, petroleum, 1·50; and the spaces occupied by quantities of petroleum and of coal would be in the ratio of 1 to 1·16; a difference in favour of petroleum too small to admit of any advantage being gained in regard to stowage. The question of price, moreover, must not be left out in such discussions. Dr. Paul argues that, since the price of petroleum varies from 15*l.* to 20*l.* per ton, whilst that of coal used for steam-vessels varies from under 1*l.* to 3*l.* 10*s.*, the cost of equal quantities of heat produced from these materials would be, under the most favourable circumstances, as in the ratio of 15*l.* to 4*l.* In addition to this, the highly inflammable nature of petroleum must be considered. Its storage on board a ship would require the use of air-tight vessels, and even then there might be considerable risk of the production of explosive mixtures of the petroleum vapour and air. What, asks Dr. Paul, would be the condition of a vessel of war provided with petroleum as fuel if

a shot penetrated the vessel containing the petroleum, and allowed it to escape in proximity to the boiler fires?

In answer to these objections of Dr. Paul, Mr. Richardson, the patentee, asserts that the relative heating-powers of petroleum and coal, as depending upon their chemical composition, is not the question; the ability of each to create steam is the real matter to be considered. Petroleum, as steam fuel, can be very nearly fully utilized: it produces no ash, submits to mechanical management, and makes little or no smoke; does not require any strong draught or current of air like coal, which will not burn without it, the consequence being that a very considerable portion of the fuel is lost, as waste heat, in the chimney. In careful experiments by Mr. Wye Williams, to ascertain the best form of boiler to obtain the greatest amount of heat from coal, he gives the temperature of the waste heat in the first experiment as 1060°; in the second, 760°; and in the third, 635°. If these are the temperatures, with a consumption of only three-and-a-half cwt. of coal in each experiment, what would be the temperature of the waste heat in the chimney of a furnace burning from twenty to thirty tons of coals per day? We know the current is so strong that it often carries up small coal and cinders along with it; that the heated gases often take fire by a spark from the furnace, and burn at the top of the funnel with a fierceness almost equalling the flame from a blast furnace. Is this flame or waste heat employed in creating steam? And how much of the coal is utilized? In practice, Mr. Richardson says, the ratio of the heating-power of petroleum and coal is about 1·4 to 0·4. The patented grate, which burns petroleum through a porous matter, proves that one ton of petroleum does as much work as five tons of coal. If four tons out of five are saved for freight space, the price of the latter being 7*l.* per ton, the profit on every ton of petroleum would be 14*l.* 15*s.*—the coal at 15*s.*, the petroleum at 17*l.* per ton. But a shipowner might not select the American crude oil at 17*l.*; he could take the Flintshire coal oil, which is quite as good for his purpose, and costs only about 10*l.* per ton. The average price of coal on a long voyage would be low at 2*l.* per ton. Taking the prices and the freight at the reduced sum of 5*l.* per ton in a ship requiring 500 tons of coal, and using instead 100 tons of petroleum, the profit by the exchange would be 2,000*l.* Respecting the highly dangerous inflammable nature of petroleum, Mr. Richardson considers it to be greatly exaggerated. If the oil were contained in cast-iron cases, securely closed, no vapour could escape; or if the small amount of spirit which produces the inflammable vapour was first extracted, the residue, the burning oil and heavy petroleum, would be no more dangerous than so much lard or spermaceti.

Lenoir's gas engine, which has been at work in Paris for some time past, may now be seen daily in use in London. In appearance, the Lenoir engine is very much like a horizontal steam-engine, having a cylinder, piston, crank, shaft, and fly-wheel. The cylinder has the necessary slide arrangements for the admission of coal gas, and atmospheric air in due proportions, which, at the proper moment, are

ignited by the electric spark. Contact is made and broken by the rotary action of the crank shaft, and the explosive force, consequent on the ignition, gives motion to the piston on each side alternately. The cylinder has a water jacket surrounding it, through which a stream of cold water is kept gradually flowing, to absorb any excess of heat. The mixture exploded is about eleven volumes of air to one of gas. The consumption of gas is as near as may be seventy feet per horse-power per hour of actual work, giving a cost, with gas at 4*s*. 6*d*. per thousand feet, of about 4*d*. Besides this cheapness, the engine is recommended by its simplicity, cleanliness, and safety. When set in motion, the machine requires no attention, and the batteries only want charging once a week.

Electricity.—A very ingenious battery, which is said to be both constant and cheap, has been proposed by Mr. Arthur Reynolds, B.Sc. The exciting liquid being a solution of perchloride of iron, and the metal to be attached metallic iron, the copper plate being replaced by carbon. The action of the battery, according to the inventor, would be quite constant, as the exciting liquid would always remain in the same condition. The iron dissolving by reducing the solution to protochloride, which being oxydized by the air, would be deposited so that the solution would always remain of the same strength. This would be as cheap, or cheaper, than any other form of battery, and perpetually constant. The purpose to which it is proposed to employ the battery, is to the manufacture of magnesium from sea-water. The sea-water should be evaporated with a little chloride of calcium, and after the main bulk of common salt and sulphate of lime had crystallized out, the solution should be evaporated to dryness. The dry mass melted and decomposed by the above-described battery.

Professor Bunsen has described some powerful thermo-electric piles, which are likely to prove of great value. Hitherto, bismuth has occupied the highest, and an alloy of two parts of antimony, with one part tin, the lowest place in the thermo-electric series. It has now been shown that pyrolusite stands above bismuth in the series, and that copper pyrites occupies a far higher place than even pyrolusite. When copper pyrites is combined with the above alloy, so as to form a thermo-electric pair, or, better still—in order to be able to employ greater differences of temperature—when copper pyrites is combined with copper, far stronger currents are obtained than, under the same circumstances, are yielded by any of the thermo-electric piles hitherto in general use. When heated to above the temperature of melted tin, the other end being cooled in water of 60° C., one single element exhibited a ten times greater action than a bismuth and antimony element of equally effective resistance when heated from 0° to 100° C. Ten of the above described pairs formed into a battery suffice to give all the actions of a Daniel's element, containing an effective copper surface fourteen square centimetres in area. Copper pyrites, in its natural state, melts easily at a strongly glowing heat without sensible decomposition, and it may then be cast into any mould whatever. It is a remarkable fact, however, that this sub-

stance thereby suffers a change, in consequence of which, it sinks far below bismuth in the thermo-electric series. Consequently it is only the mineral in its natural state, which can be employed for such thermo-electric piles; in that state, however, it can be easily worked into any required form.

It is stated by Mr. Richer, that a disc of sulphur makes an excellent machine for frictional electricity. He melts it and cools it rapidly three or four times, and then moulds it into a disc, which may be two or three centimetres thick, and a metre in diameter. Unless sulphur possesses some very remarkable properties in this respect, it is not likely that this brittle material will replace ebonite, a substance which appears to have been sent for the especial gratification of all who are in any way connected with electrical experiments. In reference to this paper, M. Deville has recalled the fact mentioned by M. Dietzenbacher some time ago, namely, that the addition of a little iodine or bromine gave great plasticity to sulphur.

The fable of Mahomet's coffin, said to be suspended in mid-air by means of powerful magnets, has attracted some small amount of serious attention on the Continent, and M. Plateau, of Ghent, has been at the pains of calculating whether it would be possible by any arrangement of magnets to suspend a magnetized needle in the air in a state of stable equilibrium without any point of support; and he announces, with regret, "Hélas," that he finds it utterly impossible.

The sulphurous waters of Bagnères de Luchon, are said, by M. Lambron, to show, when received in a glass or bath, an excess of positive electricity on the upper surface, and of negative electricity on the lower surface, and when a person is in a bath he completes a circuit, and has a stream of electricity running through him. Moreover, when a patient gets a *douche* of the water, the part of the body soused is negatively electrified, the other parts of the body being positive. It is supposed that these currents must produce a certain action on the animal economy, and it is noticed that the waters when transported from their source do not lose their electrical properties.

The adaptation of electricity to the production of motive force is attracting considerable attention in France just now. MM. Bellet and Rouve are exhibiting at Versailles a small locomotive driven by electricity. This certainly merits some attention, since the inventors do not seem to claim any extraordinary powers for their machine. They only propose it for carrying light weights, such as letters by an underground railway. The driving-wheel of the engine is made of copper, through which at equidistant intervals pass a series of horse-shoe electro-magnets—twenty in the whole circumference. The current is made to pass successively through these magnets, contact being made and broken by means of two discs at the axis of the wheel, the iron rail attracting these magnets causes the rotation of the wheel, and in the absence of great weight the vehicle progresses at an extraordinary speed; locomotives on this plan being asserted to be able to travel with ease on existing railways at a rapidity of 120 miles an hour. The batteries are placed at the termini to save the weight and the carriage, and the current is conveyed by insulated wires running between the

rails and over a roller in the locomotive. With respect to this plan an American paper enters into some curious calculations as to what such an engine would do in the way of jumping. The velocity is 181·825 feet per second; the square of $\frac{1}{10}$th of which is 516·55, which is the height to which a body moving upward at this speed would rise. Were this electrical horse to make a turn upwards at an angle of 45°, he would describe a parabola 258 feet high and 1,032 feet long.

In connection with this subject we may mention an electric brake which has been recently under experiment on the Strasburg Railway. A system of brakes attached to any number of carriages in a train is brought into operation by interrupting an electric current by means of a little apparatus attached to the tender, and thus under the control of the driver. When contact is made, and the current is established again, the brakes cease to act. Connected with this is an arrangement by which the guard and even the passengers can communicate with the engine-driver. The experiments made showed that all the contrivances were perfectly effective, trains going at great speed being brought to rest in a distance of 250 to 300 metres, instead of from 1,200 to 1,500 as by the usual system of brakes.

With an improved method of pointing pins and needles, we will conclude our chronicles of physics for this quarter. It is known that if the two electrodes of copper, iron, or steel, are set vertically in acidulated water, and reaching nearly to each other, the positive very quickly becomes pointed. The experiment can of course be made by making the positive pole of a number of wires, and carefully regulating the negative pole. Two or three Bunsen's cells only are required to do the work. Considering the diseases which arise from pointing pins and needles in the usual way, this method, which is a discovery of M. Cauderay, certainly deserves attention, although some supplementary polishing would seem to be inevitably required.

X. ZOOLOGY AND ANIMAL PHYSIOLOGY.

(*Including Micro-Zoology and the Proceedings of the Zoological Society.*)

At the annual meeting of the French Academy, on the 6th February, the awards were made to the successful competitors for prizes, and new prizes were proposed on various subjects. The prize for Experimental Physiology was carried off by M. G. Balbiani, who has already distinguished himself by his researches and discoveries in regard to the sexuality of the Infusoria. His present work has been devoted to the constitution of the germ of the animal ovum before fecundation. He has shown that, contrary to the usually-received notions, the germinating element is formed round a different vesicle to that known as the germinal vesicle, or the vesicle of Purkinje. MM. Siebold, Wittich, and Victor Carus, had formerly observed in a spider's egg, a particular corpuscle distinct from this vesicle; but it had occurred to no one that this observation was of fundamental importance.

The general demonstration of a focus distinct from the germinal vesicle round which the first materials of the germ group themselves, extensively modifies our knowledge of the manner in which the rudiments of an organism is formed. It opens out, therefore, a way to studies which will enable us to penetrate nearer the origin of living beings.

Another prize has also been awarded to M. Gerbe, for his discovery of the reproduction of Kolpods. In his researches on the embryology of marine crustacea he observed that the kolpods connected themselves by pairs, after the manner of the conjugation of confervæ. Following this conjunction, unique in the animal kingdom as far as is known at present, he has shown that in the common matrix formed by the fusion of the two individuals of each couple, the reproductive organ of each is divided into two, and four reproductive ovules are thus formed in the matrix, which then dies. These oviform germs are soon disengaged, showing living and moving kolpods, in precisely the same manner as does the newly-born conferva. It will be seen that M. Gerbe's observations supply us with an analogy between the generation of animals and that of plants.

Prizes of 3,000 francs are offered for the following subjects, the essays to be sent in by November 1st of the present year:—1st. An inquiry whether in those animals of which the eggs are impregnated after they are laid, hybrid products can result from a mixture of animals of species not nearly allied; also, whether the vitality of these abnormal productions so obtained is in relation with the degree of heterogeneity of their parents; by which experiments it is hoped that interesting results may be obtained on the subject of the *fecundity of hybrids*, and of the degree of fixity of their zoological characters. 2nd. A comparative study of the nervous centres of the encephalon of fishes, in order to demonstrate rigorously the analogies and differences which exist between their functions in fishes and the higher mammalia, and to throw light on the zoological affinities between the different species of fishes themselves, and furnish fresh data for their classification. 3rd. An osteographical work which shall most contribute to the advancement of French Palæontology, either by making better known the anatomical characters of one or more types of vertebrata, and in thus furnishing important elements for the study of tertiary faunas; or treating in an exhaustive manner of the fossils which belong to one of the least known classes of this great branch of the animal kingdom.

While referring to prizes, it may be mentioned that the Royal Society of Edinburgh offer a Neill prize, consisting of a gold medal and a sum of money for a paper of distinguished merit on a subject of natural history by a Scottish naturalist, which shall have been presented to the Society during the three years preceding May 1st, 1865; or, failing presentation of a paper sufficiently meritorious, it will be awarded for a work or publication by some distinguished Scottish naturalist, on some branch of natural history, bearing date within five years of the time of award (*viz.* the commencement of the session 1865–6).

Dr. Humphry, in a communication to the Cambridge Philosophical Society, defends the vertebral theory of the skull on the ground of the constancy of the law of uniformity of plan with variety of detail. It is by all anatomists admitted that the skull is segmentally constructed, and most anatomists are agreed as to the number of the segments. He argues that they should therefore be described by the same name as those of which they are a continuation, since the segmental construction of the skull—the relation of its components to surrounding parts, and so many fundamental resemblances in development, unite to prove that one as well as the other consists of vertebræ modified to meet the requirements of the parts in which they are found. Although, therefore, Professor Huxley has expressed an opinion that the vertebral hypothesis of the skull has been abolished by the recent discoveries in development,* Dr. Humphry affirms, that the greater number of those anatomists to whose observations we are indebted for most of our knowledge of the development of the skull and of the trunk, are agreed that the differences between the mode of formation of the segments in the two form no real argument against the vertebral character of either.

Professor Peters, in a paper before the Academy of Sciences at Berlin, adds another to the exceptional cases of mammals having more or less than seven cervical vertebræ. The only exceptions previously known were the genera Bradypus (Sloth) and Manatus (Manatee). In the former the number varies from eight to ten, and in the latter it is usually six. The example now added by Peters is a species of two-toed sloth, described by him in 1858 under the name of *Cholœpus Hofmanni*, of which he has received several skeletons, all of which present only six cervical vertebræ.

It is remarked by the natives and old settlers of New Zealand, that many of the native birds are getting scarcer, and a few varieties have all but disappeared. A collector remarks, that of birds which were formerly common he has failed in getting even a single specimen. Early navigators and visitors to New Zealand speak with raptures of the melody of the birds in the woods at early morn. But that the birds are now rapidly disappearing appears certain; and it is suggested that the cause is, the ravages of the common rat. The Bush and country are swarming with them; they are found in the trees, on the ground, by the water and in the water. Rat life is rampant at the present moment in New Zealand. Birds' nests are found empty everywhere where they ought to have been tenanted, and are almost invariably robbed by the vermin; so that a progressive extinction of the native fauna appears to be an inevitable result of the undue increase of that prolific pest, the rat.

Singing mice have long been known, and the fact of their singing is beyond question, and have supplied the substantial evidence of a good income to the fortunate owners of these musical phenomena. Another well-authenticated instance has occurred at Ashcroft, in Kent,

* *See* his recent lectures on Comparative Anatomy.

of a mouse, which having been caught, continued its song in captivity. On disturbing it when asleep, a low chirping is heard such as is frequently made by young birds in a nest, but presently the sound begins to increase until it can be heard all over the room. The song is described as very pleasing, although rather monotonous, somewhat resembling the lower notes of a nightingale. The mouse seemed to appreciate its own singing powers, as it kept standing on its hind legs, and raising itself up as its lower notes grew louder. Mr. E. Newman suggests, as an explanation of these musical prodigies, that the performers are afflicted with some lung disease, perhaps tubercular phthisis, or that infirmity which in horses is called whistling. But whether this is a satisfactory explanation remains to be proved.

Mr. A. Fonblanque, of the British Consulate at Alexandria, has communicated to Mr. Darwin a notice of a curious birth which has lately taken place at Cairo—that of a foal produced by a mule. Mr. Fonblanque says, so great was the excitement at this unheard-of event amongst the native population, that it produced an official inquiry, a copy of which, together with a certificated translation, Mr. Fonblanque has forwarded along with his letter announcing the prodigy. The latter consists of the deposition of one Mohammed Effendi Ashmani, a veterinary surgeon, before the police at Cairo, on the 27th June, 1864, and states that on the previous day the said Mohammed had proceeded, in pursuance of instructions received, to the house of one Ibrahim, to examine a mule which had produced an offspring. It appears that the said mule had been covered by an ass, as the offspring is a jennet. The mule is twenty-two years of age, and as she has no milk, which is indispensable to maintain the jennet, directions were given for feeding it. Mr. Fonblanque does not believe that "any intentional deception has been practised. No attempt has been made to turn the affair into profit by exhibition or otherwise; in fact, it furnished considerable annoyance to the owner of the animal."

After several ineffectual attempts, the authorities of the Zoological Gardens succeeded in adding a live porpoise to the attractions of the Regent's Park. It was captured at Deal by some fishermen, and transported to London early in January, and, although somewhat bruised from attempts to escape capture, it gradually improved, and regained its appetite, taking its meals regularly. These consisted of live eels, which it caught for itself, also herrings, and other fish, supplied by the keeper at the end of a fishing-rod. It was hoped that the re-establishment of its health would have ensured it as a permanent addition to the collection, but unfortunately, during the frost, it suffered so much from exposure in its *shallow* pond that, to the great disappointment of all concerned, it died after a few weeks' confinement.

A gorilla, which was sent recently from Africa by M. Du Chaillu for the Gardens of the Zoological Society, unfortunately died on the passage to this country.

Dr. Lionel Beale, in continuing his investigations upon the tissues, has maintained some views of the relations of the round and caudate

nerve-cells, which are not without interest. In a paper read before the Royal Society, he remarks that the caudate cells are really not *cells* nor *vesicles*, in the ordinary acceptation of the terms, for there is no investing membrane and cell-contents, but the so-called cell consists of soft solid matter throughout. The nerve-fibres are not prolonged from the nucleus, but are continuous with the very material of which the substance of the cell is composed. From various observations upon the course taken by the tubes through the cells and into other fibres, he concludes that the typical anatomical arrangement of a nervous mechanism is not a cord with two ends—a point of origin and a terminal extremity, but a cord without an end—a continuous circuit. From the peculiar structure of the caudate nerve-cells, he thinks it improbable that they are *sources* of nervous power, while, on the other hand, the structure, mode of growth, and whole life-history of the rounded ganglion-cells, render it very probable that *they* perform such an office. These two distinct classes of nerve-cells, which are very closely related, seem to perform very different functions—the one *originating* currents, while the other is concerned more particularly with the distribution of these, and of secondary currents produced by them, in very many different directions. A current originating in a round *ganglion* cell would probably give rise to many induced currents in a *caudate cell*.

An egg of the New Zealand Moa has been found in the Middle Island under singular circumstances. A labourer who was digging the foundation for a house came upon the egg, and unfortunately, with his pick, broke some portions of the shell. It was in the hands of the skeleton of a Maori, who was buried in a sitting posture, with the egg resting in his hands, and held opposite to his head. The egg is about 10 inches long, and 6¾ inches in width, and of a dirty-white colour. It has been placed in a box and protected by glass, so that the injury is not perceptible, and the egg appears to be perfect. It has been suggested that this discovery does not tend to prove that the Moa has recently existed, inasmuch as the egg was probably in a fossilized condition; for the shell of the Dinornis, unlike that of the Æpyornis, is comparatively slight, and, therefore, likely to have been shattered by a heavy blow from a pickaxe, whereas the egg remains perfectly sound, except upon the side accidentally chipped. Probably the egg was intended as a provision for the journey to the realms above, or, as the Maories say, possibly to the regions below; but there appears to be no record of the custom of placing such objects in the hands of the dead.

Pisciculture is practised with much success in Belgium, and M. Schramm, the Director of the Botanic Garden at Brussels, has recently received a first-class medal from the Acclimatization Society of Paris, for his labours in this direction. The Society at Brussels has just completed the fishing of their pond in the Botanic Garden, for the purpose of obtaining a supply of ova for artificial propagation. Two hundred and fifty salmon and trout obtained in this manner furnished

about 40,000 ova, which were immediately placed in the hatching apparatus. The fish were from three to five years old.

Professor Agassiz has laid before the Paris Academy a remarkable paper upon the "Metamorphoses of Fishes," which he states are, according to his observations, as important as those of Reptiles (Amphibia). At the present time, when pisciculture is so much studied, it appears remarkable that such metamorphoses should not have been sooner observed, but Agassiz accounts for it by the fact, that the metamorphoses generally commence immediately after hatching, at which period the fishes die rapidly when kept in captivity. He says he is prepared to show that certain small fishes, which at first resemble Gadoids, or Blennioids, gradually pass to the type of Labroids and Lophioids; and that certain embryos, similar to the tadpoles of the frog or the toad, take by degrees the form of Cyprinodonts—that certain Apodes are transformed into Abdominal fishes, while some Malacopterygians (soft-finned) are changed into Acanthopterygians (hard-finned); and, further, that a natural classification of Fishes can be founded on the correspondence which exists between their embryonic development and the complication of their structure in the adult state. M. Agassiz lately discovered that the metamorphoses of some members of the family of the Scomberoids are still more unexpected. All ichthyologists know the generic characters of the Dory (*Zeus faber*), and the peculiarities which attach it to the family of the Scomberoids. Another fish, less known, but more curious, which lives also in the Mediterranean, the *Argyropelecus hemigymnus*, has been generally classed with the Salmon family, or placed with the salmon as a subfamily. Systemic authors have generally considered the *Scomberoids* and *Salmon* as very different fishes, the first being Acanthopterygians, and the second a Malacopterygian. But the *Argyropelecus hemigymnus* is nothing else than a young *Zeus faber*. Agassiz says he expects ichthyologists to declare this opinion erroneous, but, in reply, he invites them simply to compare specimens of Argyropelecus with young Dories, 8 to 10 decimètres in length.

In connection with the discoveries of M. Agassiz, it may be remarked that observations of a similar tendency have been made on the Crustacea by M. Gerbe, in conjunction with M. Coste, from which it appears that the larvæ of the *Palinuri* are identical with the species of the curious genus *Phyllosoma* (glass crabs), possessing the same peculiarities, as absence of branchiæ, flattened membranous and diaphanous body, &c. There are differences, however, such as the absence of the false feet which are attached to the abdominal segments of the Phyllosoma, and of the caudal fin of five laminæ, which at first would appear to negative the resemblance. But these are only transitory differences, which are effaced in the course of the first four or five changes of skin. All the marine Crustacea, according to M. Gerbe, make their appearance in a larval form, and immediately after birth all of them undergo the first moult. But in no species, not even in the Lobsters, which of all Crustacea are hatched in the most perfect condition, does this first metamorphosis cause the appearance of the

lateral laminæ of the caudal fin, and the false feet. The organs remain latent, the latter until the second month, the former until the third. At each moult some organs become complete, others acquire more and more their normal form, whilst others make their first appearance to arrive subsequently at their final perfection. It is probable, therefore, that the same species of Phyllosoma in different moults, has been described under various names, and M. Gerbe feels assured that he will soon be able to prove that if the Phyllosomata of authors present more perfect characters than the larva of the Palinurus, as described, it is because they have undergone several metamorphoses, and, consequently, represent subjects in a more advanced state of development. *Phyllosoma*, therefore, bears the same relation to *Palinurus* that the Zoëa does to the Crab.

M. Guyon has communicated to the French Academy some researches upon the poison of Scorpions, from which he deduces that it is identical in its character with that of serpents, both affecting animals in a similar manner. Both poisons produce more violent effects upon small animals than on large ones, and on warm-blooded than upon cold-blooded ones. The scorpion's sting is followed by immediate violent pain, and general itching, tumefaction, and extravasation of blood into the subcutaneous cellular tissue. Tremblings, vomiting, and great prostration succeed. Respiration is accelerated, and coma ensues in fatal cases, with dilatation of the pupil. Tetanic spasms of the extremities (more frequent in birds than in mammals), and remarkable disturbance of the genito-urinary organs, also occur in many cases.

Dr. V. Hensen has shown that the Crustacea possess a delicate sense of hearing, and describes the organs by which this sense is developed. His researches have extended to twenty-eight species of crustacea. In the higher forms a delicate nervous filament enters a chitinous hair, which is connected to the rest of the chitinous skeleton in such a manner as to allow of vibrations under the influence of sonorous undulations. The extremity of the hair often penetrates between the otolites, or even into the interior of one. The otolites are thrown off at the periodical moult, together with the chitinous tunic, and are replaced by others, and the minute lapilli are introduced by the animals themselves into the auditory sac. In crustacea with a closed sac, however, they present a peculiar structure, but still they shed the auditory apparatus, which is reproduced anew. The *auditory hairs* are of three kinds:—1. Hairs with otolites; 2. Free hairs of the auditory sacs; and, 3, Auditory hairs of the outer surface of the body. The first are generally curved, and recall the setæ in the orditory organ of fishes. The Brachyura (crabs, &c.) have no otolites, but their auditory sacs are nevertheless furnished with hairs, of which he counted 300 immersed in the fluid of the auditory sac of the common shore-crab. Inasmuch, therefore, as auditory hairs may be thrown into vibration without the mediation of otolites, M. Hensen thinks it is probable that they may be equally capable of fulfilling their functions if they were placed on the surface of the body. These conside-

rations have led him to regard as acoustic organs certain hairs upon the surface of the crustacea, which present the same structure as the hairs connected with the otolites. They are especially numerous in those species, or in larvæ, which have no internal auditory organs, and are renewed at each moult. Their structure is much more complex than the other hairs of the surface, which latter are wholly devoid of any nervous cord. Supposing that each auditory hair was capable of being thrown into vibration by a determinate note, he subjected the matter to experiment, and found that on sounding different notes of the gamut certain hairs became indistinct by reason of powerful vibrations, while the neighbouring hairs remained perfectly still, or could only be made to vibrate by other notes.

M. Jourdain has investigated the eyes of the common starfish, and finds that they are more highly developed than is commonly supposed. Of the two fundamental types of the organ of vision, *viz. eidoscopic* eyes, which furnish images, and *photoscopic* eyes, which only are fitted for giving a general sensation of light and darkness, he gives reason to believe that in *Uraster rubens* there is a specialization of function which no doubt represents the highest type of organization of photoscopic eyes. Eidoscopic eyes are found in the Mollusca, Insecta, and Crustacea, and are connected with an expansion of a nerve of special sense, upon which luminous rays are isolated. The photoscopic eye is associated, in its simplest form, with blackish or reddish pigment, of definite structure, in connection with the nervous system, or only with the sarcodic mass, as in the genus Lycoris. But in the well-known pigment spots of the star-fish, situated in the interambulacral furrows, at some little distance from the extreme end of the rays, there is received a filament from the ambulacral nervous trunks, which filament becomes dilated into a ganglion on penetrating into the papilla. The papilla is surrounded by spiniform calcareous processes, which are separated from each other by muscles, so as to expose the visual organ to the rays of light; but when the processes are approximated over the oculiferous papilla, the eye is, so to speak, shut, either for the suspension of vision, or for the protection of the organ. With high powers of the microscope the papilla is seen to be hollowed into numerous little cavities, lined by pigment, and connected at the bottom with the nervous ganglion. These depressions are filled with a very transparent gelatinous matter, forming a slight projection at the surface of the tubercle, and terminated by a convex portion, like the cornea of the higher animals. The presence of this refractive substance gives the eye some claim to be considered as eidoscopic in its character; and it doubtless serves to collect and concentrate the luminous rays upon the impressionable pigment, and consequently to render the perception of light, and of its different degrees, more intense and perfect.

Dr. Cobbold, well known for his study of the Entozoa, has published a pamphlet (on a new Entozöotic malady) in which he foretells the almost inevitable increase of parasitic diseases in general, if the proposed extensive utilization of sewage be carried out. Referring to the

African "flake" epidemic, he states, as proving the extensive prevalence of this disease in Egypt, that out of 363 *post-mortem* examinations conducted by Dr. Griesinger, these parasites were found in 117 cases, so that one-third of the entire population appears to suffer from their inroads. This parasite has made its appearance in this country, and it would appear that it is as prevalent at the Cape, at Natal, and in the Mauritius, as in Egypt. "In the advanced stages of the malady," Dr. Cobbold observes, "the afflicted individual must frequently evacuate the ova and their embryonic larvæ, which will do no harm if conveyed into a cesspool, or by a common sewer into the sea. But if scattered broadcast, they will be spread over thousands of acres of ground, placing the larvæ on conditions favourable for their next stage of growth, in which stage they will penetrate the bodies of land and water snails; after which there is every reason to believe that they will experience no greater difficulty in gaining access to our bodies here in England than obtains in the case of those same parasites attacking our fellow-creatures in Africa." And he foretells that in twenty years the parasitic malady would be as prevalent in this country as it is now in some particular sections of the African continent.

Two distinguished ornaments of our science have been added to the list of the dead during the last few weeks. The one was Dr. Falconer, described as one of the greatest Palæontologists who ever lived, and whose life, devoted to science, was brought to a close by disease contracted during his long residence in India, the scene of his chief labours. The second was Gratiolet, Professor of Zoology at Paris, whose researches on the comparative anatomy of the nervous system, and structure of the brain, had placed him in the foremost rank of scientific men of the present day. He died of apoplexy, on the 17th February, not having reached his fiftieth year.

Proceedings of the Zoological Society of London.

At each meeting of this Society numerous communications are read, extending our acquaintance with the fauna of some distant part of the world, or rendering the knowledge of our own fauna more systematic and precise. As usual, Dr. J. E. Gray has been foremost in his industrious accumulation of facts. Papers have been communicated by him on a new species of Whalebone Whale (Eschrichtius robustus), founded on a specimen stranded on the coast of Devonshire in 1861, and portions of whose skeleton have been obtained for the British Museum; also upon another species (of the Right whale), whose atlas and cervical vertebræ appear to indicate the existence, in the Antarctic Seas, of a new form of this group. The specimen has been named *Macleayius australiensis*. Another new species of whale has also been described by Dr. H. Burmeister, founded upon a skeleton in the Museum of Buenos Ayres, and called by its describer *Balænoptera patachonica*.

Dr. Gray has also brought forward important revisions of two families of Carnivora—the Ursidæ and Mustelidæ—from specimens in the British Museum. Of the Ursidæ there are ten genera and twenty-two species, nine inhabitants of the old and twelve of the new world, while one is common to both. Of the Mustelidæ there are twenty-three genera and forty-seven species, of which ten are peculiar to the new world.

Dr. Kirk, the companion of Livingstone, enumerates the mammals, sixty-seven in number, met with in the Zambezi region of Eastern Tropical Africa, amongst them a bat and an antelope new to science.

With regard to birds, Professor Owen has contributed a ninth memoir upon Dinornis, chiefly descriptive of the skull, and founded upon the skull discovered, with an almost entire skeleton of the bird, in the Valley of Manuherika, Otago, and now in the museum of the Yorkshire Philosophical Society. Professor Bianconi, of Bologna, communicated a letter relating to the systematic position of the extinct Madagascan bird, the *Æpyornis maximus*, which he was of opinion should be referred to the Vulturidæ. New species of birds have been added from Rodriguez, by Mr. Newton; from Benguela, by Mr. J. J. Monteiro; and from Australia, by Mr. Gould, discovered during the recent exploration of the interior of that country. The discovery of some bones of a large species of Dodo in a cave at Rodriguez, by Mr. Newton, is also worthy of notice; and the occurrence in this country, for the first time (near Newbury), of the Carolina Crake (Porzana Carolina). A remarkable Australian lizard (Moloch horridus) is stated to have been recently captured alive in Jersey, to the no small excitement of the islanders, and a photograph of the intruder was exhibited by Mr. Sclater. The fishes of Cochin, on the Malabar Coast of India, have been described by Mr. Francis Day, in a memoir devoted to the Acanthopterygii, of which 120 species are enumerated, including several new to science; and Dr. Günther has presented an account of his researches into the British species of Salmonoid fishes. He states that the genus *Salmo* is essentially an Arctic group, inhabiting the northern portions of both hemispheres, the species becoming more abundant upon receding from sub-tropical to temperate latitudes. He is disposed to believe that the species to be found within British waters are more numerous than hitherto suspected, and he has made out four new species of the non-migrating group of true *Salmo*, besides identifying several others heretofore imperfectly distinguished. He distinguishes five of the sub-genus Salvelinus (charrs) inhabiting Windermere (the original habitat); Llanberis, Scotland; and Loughs Melvin and Eske in Ireland, respectively. Of the sub-genus *Salmo*, three are migratory species, *viz.* the true Salmon, the "Sewen" of South Wales, and the Sea-trout of Scotland; while eight are non-migratory species—*viz. S. fario* of England, *S. Gaimardi* of Scotland, *S. Levensis* of Loch Leven, and *S. ferox* or Great Lake Trout; with the four new species above mentioned, called respectively *S. nigripennis*, inhabiting mountain lochs of Wales, *S. orcadensis* (Orkney

lakes), *S. brachypoma* (Firth of Forth), and *S. stomachicus*, (Ireland).

Several interesting additions to the Society's collection have been made, *viz.* a fine male Mantchurian Deer from Mr. Swinhoe; and the prong-horned Antelope of America (Antilocapra Americana), the first instance of this animal's having reached Europe alive. Dr. Bennett, of Sydney, has in the gardens of the Acclimatation Society of Sydney, N.S.W., a specimen of the Lyre bird (Menura Novæ Hollandiæ), intended to be transmitted to London by the first opportunity. Finally, Dr. Schlater reports that there are in the gardens seventy-four specimens of the Quadrumana, belonging to forty-three different species, amongst which are several of great rarity.

REVIEWS.

THE GEOLOGICAL SURVEY OF INDIA.*

It cannot but be considered highly creditable to the East India Company, that during their rule over that great limb of the British Empire, Hindostan, they did not neglect projects which had reference to the future permanent benefit of the whole country, but of whose immediate utility in a mercantile point of view there could be little prospect. The establishment of a Trigonometrical Survey, to be followed in course of time, after the example of the mother-country, by a Geological Survey, could scarcely be looked upon as likely to be a good investment for capital (so to speak) at the time when these Surveys were projected. Yet even now they are bearing fruit, in giving facilities for laying out lines of railway, for the sale of public lands, and for defining the limits of formations producing coal, iron, and other minerals. The value of such undertakings to the cause of science and the advancement of the arts need not be insisted upon here; so general is the recognition of the importance of good Topographical and Geological Surveys, that there is scarcely a country in Europe and America, or a dependency of the British Empire, where they have not been originated and sustained by their respective Governments.

The Geological Survey of India has been in existence about seventeen years, under the superintendence of Dr. Oldham, who previous to his appointment had the advantage of several years' experience as Director of the Geological Survey of Ireland. His staff of assistants has been gradually augmented, and is largely drawn from that country; and it is somewhat remarkable, that in looking through the Report of Dr. Oldham, we do not recognize the name of a single Scotchman! We do not, of course, venture upon so rash an inference as that amongst the dozen officers or so of the Indian Survey, there is not one single native of that fortunate country, which supplies men to most of the good appointments all over the world. We trust, indeed, that such is not the case, as it would speak but ill for the prospects of the Indian Survey.

The Geological Survey is now at work in three distinct regions of the Indian Peninsula, about equally distant from each other. During

* 'On the Geological Structure of the Districts of Trichinopoly, Salem, and South Arcot.' By William King, junior, and R. Bruce Foote. Calcutta: Thacker. London: Williams & Norgate.

'On the Structure and Relations of the Southern Portion of the Himalayan Ranges between the Rivers Ganges and Ravee.' By H. B. Medlicott, A.B., F.G.S. Same publishers.

'Annual Report of the Geological Survey of India for the year 1863–4.' By Thomas Oldham, LL.D., Superintendent. Calcutta: O. T. Cutter.

the year 1863, a tract of country stretching across the peninsula from the Gulf of Cambay to the mouth of the Ganges has been completed. This was an object steadily kept in view during several years, and as the relations of the rocks along this belt have been determined, a basis has thus been formed for the extension of the work towards the north and south. Another belt, farther south, in the parallel of Kurnool, Bellary, and Goa, is now in course of examination, and will form a portion of the work of several years to come. In the meantime, the rocks along the southern flanks of the Himalaya are being mapped, forming a third belt to the northward, so that we presume the intention is to extend the work in a series of parallels over the intervening districts until they form a junction.

For a region of such vast extent as India, and of the relationship of whose rocks we have so imperfect a knowledge, the above plan may be—and doubtless is—the best. In a country, however, such as England, in which the formations are arranged in so symmetrical a manner, that we can make a traverse from the oldest to the newest formations along a given straight line, the obvious course is to commence with the former, and work up to the latter; and this is the general plan which has been adopted by the English surveyors. But in India it is otherwise, and although the Himalayas offer an apparent base, yet such are their dimensions, both lengthways and vertically, such the physical difficulties likely to be offered in any attempt to unravel their structure, that at least one generation would have passed away ere such a Herculean task could have been accomplished. We therefore assume that the apparently unsystematic plan of operations which is represented on the Index Map accompanying Dr. Oldham's Report (which also shows certain favoured spots of which surveys have been made, scattered at wide intervals over the Indian Empire), has been adopted, in obedience to economical, scientific, or perhaps Imperial requirements. Some of these are indeed apparent from the Reports of the surveyors themselves, as we find their regular work frequently interrupted by orders from Government to proceed to some spot, mayhap many hundred miles distant, to report on some special district. Thus we find that Mr. W. T. Blanford, during the year 1863, was detached on temporary duty to examine a reported coal-field in Sinde; and Dr. Oldham himself, while engaged in company with Mr. Medlicott in examining a very important area, extending from Monghyr to the Sone, was ordered to proceed at once to the Punjab, to examine and report upon the deposits of so-called coal in the Salt range. Such interruption must sadly interfere with the steady progress of the Survey; and now that most of the real or imaginary coal-bearing districts have been visited by the officers of the Survey, it is to be hoped that their systematic labours will be less frequently interfered with.

The districts treated of in the two memoirs before us lie almost at the two extremities of the Peninsula. That described by Mr. Medlicott embraces an area of 7,000 square miles, in a region peculiarly attractive from its physical features, being composed of those picturesque ranges which form the frontiers of the Himalayas in the

Punjab. The Sub-Himalayan hills are often of considerable elevation, reaching altitudes of 10,000 or 12,000 feet, and culminate in the Peak of Chor and in the Dhaoladar ridge. This latter ridge, composed of granitoid gneiss, and ranging nearly in a north-westerly direction, forms, in the opinion of the author, the extreme north-westerly prolongation of the "Eastern Himalaya," from which, however, it is severed by the deep valleys of the Beas and Sutlej. To the north-west, the Dhaoladar ridge sinks down, and is terminated along the valley of the Ravee, while the "Western Himalaya" rises to the north of this ridge, and ranges in a nearly parallel line between the Chenas and the Indus. Mr. Medlicott has good Geological reasons for the view he adopts regarding the line of division of the Eastern and Western Himalayas; and it is an interesting fact, first noticed by Colonel Cunningham, that the subordinate hills of the Western Himalaya range in lines parallel with the central axis, while those of the Eastern run out at right angles from the main ridge. The causes of this distinction are considered to lie in certain changes in their Geological structure.

Mr. Medlicott separates the rocks of the region of which he treats into two great groups, each of which is capable of farther subdivision—namely, "The Himalayan" and "Sub-Himalayan." The stratigraphical distinction between these two great groups is most marked. The former composes the interior central range (as far as he has examined it), and consists of limestones, shales, sandstones, slates, quartzites, schists, and gneiss; the latter consisting in the lower part of shales, with nummulitic limestones, and passing upwards into an assemblage of strata in which sandstones and conglomerates largely predominate. Of the age of the "Himalayan" group no opinion can at present be formed, owing to the almost entire absence of fossils. The author has only succeeded in finding a few obscure impressions of bivalve shells in a band of limestone, which do not throw any light on the subject; but in the succeeding group of the "Sub-Himalayan" beds, we pass from rocks of whose age we can only form vague conjectures to those of an age strongly defined in the Geological series. Between the two groups there is in all probability a vast gap in time, as M. D'Archiac refers these Himalayan beds, though with hesitation, to the Devonian period. The shales and limestones of the "Sub-Himalayan" series contain shells* and nummulites, which enable us to refer these beds to the early Tertiary age with the same amount of certainty that we refer a coin stamped with the effigy of one of the Cæsars to its period in Roman history.†

From what has been stated above, it is not to be inferred that we are unacquainted with the age of any of the rocks which compose the lofty range of the Himalayas. Through the labours of Captain Strachey and other explorers we have been made acquainted with groups, some of which rise into the loftiest altitudes, charged with

* A list of which is furnished by Dr. Kane, pp. 99–100.

† For the sake of the general reader, it may be explained that "nummulite" means a stone-coin; and the stone of which the Pyramids are built is mainly formed of nummulitic rock. J. B. Jukes's 'Manual of Geology.'

fossils referable to the Silurian, Triassic, and Jurassic ages. Thus the highest passes into Tibet, at elevations of 20,000 feet, are formed of slates and limestones, containing *Asaphus, Cybele, Cyrthoceratites*, and other Silurian forms; beyond these are limestones, with *Ceratites* of the Muschelkalk, while beds with organisms resembling those of the Lias, Cornbrash, and Oxford clay follow in succession.

The whole of these formations of the two groups have undergone an extraordinary amount of disturbance. The beds are often vertical, and even inverted. In other cases they are broken by faults, and with such physical and stratigraphical obstacles to contend against, we cannot but consider that much credit is due to the author for disentangling the complicated structure of these rocks.

The "Subathu" beds are followed by the "Nahun" and "Sivâlik" rocks, which are somewhat similar to each other in character, being principally sandstones and conglomerates of great thickness; they have, nevertheless, a very marked line of division. This is illustrated by the section in the Narkunda which forms the frontispiece to the memoir. The upper series of sandstones seems to have been deposited against, and upon, a denuded surface of the lower series, which apparently formed a line of high cliffs and hills facing the open sea to the south. The break thus shown between the two groups indicates a second period of elevation in the Himalayan range. The Sivâlik beds are in turn succeeded unconformably by the nearly horizontal strata of the Ganges valley.

It would, of course, be hazardous to draw any general conclusions regarding so comprehensive a subject as the upheaval of the highest range of mountains in the world, from an examination of a limited portion of the entire length; and Mr. Medlicott very properly qualifies his remarks on this topic with the proviso, that they are open to subsequent alteration. Nevertheless, his views are novel and well supported. The usual opinion, founded on the fact that the Tertiary sandstones of the Sivâlik group dip towards the "Himalayan" beds, is that these older rocks are upheaved along an enormous fault or fracture. The author, however, seems to consider that the direction of the dip is due to foldings arising from enormous lateral pressure, and that the line of contact is not strictly a fracture, but an original margin of deposition. The discordances amongst the Tertiary beds themselves are evidence of a succession of elevations at intervals; and it would appear that the whole of the formations along the flanks of the mountains have, at a very recent period, been subjected to a process of crumpling, caused, as the author supposes, by the falling in to a certain extent of the entire mountain range.

In the case of the memoir of Messrs. King and Foote, we have not the advantage of a map.* The description of the district is, however, sufficiently clear to enable us to dispense, for the present, with a document so essential to a thorough understanding of the subject. There are, besides, several coloured longitudinal sections, which convey at a glance an idea of the general structure of the country.

* The map is expected to be published ere long.

The country treated of consists for the most part of highly-inclined metamorphic rocks, principally gneiss, with bands of crystalline limestone, trap dykes, and magnetic iron. The Geological age of these rocks is altogether uncertain, and they are succeeded by the Cretaceous and Post-Cretaceous formations of the Payen Ghat, or low country of the Carnatic. These latter form extensive plains or terraces, stretching from the interior to the coast in some places, while in others they are overlaid by very recent deposits of fluviatile, or marine origin, in which shells identical with those now inhabiting the neighbouring sea have been found. The alluvial deposits of the deltas of the Cauvery, Punniar, and Guddelom rivers are very extensive, and owing to their liability to floods from the rivers themselves are rescued from the curse of barrenness which overhangs the sandy plains by which they are bounded. In the interior, the crystalline and metamorphic rocks rise into several lofty ranges, belonging to the Eastern Ghats, of which the most distinguished are the Shevaroys, which, in the Green Hill Ridge, reach an elevation of 5,260 feet. This mountain is deeply indented by ravines, especially that of the Vaniaur river, a tributary of the Punniar. Along the sides of this ravine nearly perpendicular walls of bare rock rise to a height of a thousand feet, and the authors speak with rapture of the grandeur of the views along the road from Yercaud to Shenguttapady from the brow of these splendid precipices.

Space forbids a further reference to the general Geology of this interesting region, though there are several points upon which we should gladly linger. We therefore hasten on to notice that special feature which renders the Salem district almost unique in a mineral point of view. We refer to the wonderful hills of magnetic iron ore, which have rendered this district famous from very ancient times. These iron-beds occur in many places throughout the country of Salem and South Arcot. They are interstratified with the gneissic, or metamorphic rocks, following their foldings, or running for miles along the ridges of the hills with marvellous persistency. In the district under consideration there are four distinct groups of these iron-beds, some of which, as that of the Godumullay hills, form the serrated crests of the ridges, rising upwards of 1,200 feet above the valleys. On the northern side of this ridge, the iron-rock suddenly terminates in a splendid precipice several hundred feet high, overhanging in some places. These massive cliffs form the subject of the frontispiece to the memoir.

The most remarkable of these masses of magnetite lies just beyond the western limits of the district, and is therefore described in the appendix—it is the ridge of Kunjamullay.

The ridge attains an elevation of 2,000 feet above the sea, and of 1,000 above the surrounding plain. It is of an elongated form, four miles in length; and around its flanks, several beds of magnetic iron crop out in a series of oval rings, imbedded in garnetiferous gneiss and other schistose rocks, and dipping at every point towards the centre or axis of the ridge. From this description it will be apparent that the ridge is coincident with the axis of a synclinal fold, and that

the bed of ore which plunges inward on one side rises to the day on the other. Four or five bands of ore have been observed, and can be traced at intervals, through the thick scrub all round the circumference. The two lowest beds are each about 50 feet in thickness; and the authors remark that they are exceedingly conspicuous even when seen from a distance, especially when the morning or evening sun deepens the shadows, and lights up the projections. At such times these iron-beds may be seen encircling the hill in sharply-cut terraces of grey or purple colours. From the base of the hill, and extending for a distance of two miles or so, the ground is strewn with rounded blocks of ore, while the sides of the hill itself are in places thickly coated with a *talus* of the same material; in fact, nature has here carried out mining operations to such an extent, that the largest furnaces might be fed for years with the rough-hewn ore.

These beds of iron follow all the convolutions of the schistose rocks with which they are associated; and their laminæ of quartz are observable in hand specimens alternating with those of ore. The average yield is about 55 per cent. of pig-iron, which for every ton smelted requires 13¼ tons of charcoal. The steel made from this ore by the natives is of the finest description; and we have been informed by an English officer long resident in that district that there is documentary evidence to show that the famous Damascus steel, and those scimitars of whose wonderful exploits we read in the 'Arabian Nights,' were wrought out of the ore of these hills. Be that as it may, there is no question as regards the degree of temper to which the native craftsmen, by their rude and simple process of manufacture, are able to bring the metal, which cannot be surpassed, if equalled, by the European, with all his aids and appliances.

The ore is worked by the British Porto Novo Company, at Poolamputty, on the left bank of the Cauvery. It has to be conveyed from 20 to 25 miles before smelting, and when manufactured, is carried down the river during floods. The fuel is charcoal, which appears to be fast decreasing from the wasteful manner in which the scrub wood is used up, combined with the general neglect of planting. Government has for a long while established a Forest Conservancy Department; but as yet it has had little power to materially diminish the evil.

The memoir of Messrs. King and Foote we consider to be an excellent specimen of what a Geological Survey Memoir of an Indian district should be. It is carefully and clearly written, well arranged, and treats of those collateral subjects of climate and physical geography which depend so greatly on the geological conformation of the country.

In Mr. Medlicott's memoir there is (as it seems to us) a certain want of conciseness and methodical arrangement of the subject. We object to two such terms as "Sub-Himalayan" and "Infra-Himalayan" being applied to designate two series of strata, as being likely to cause confusion in the mind of the reader; and there is a degree of vagueness in the wood-cut sections which is highly embarrassing. Perhaps the engraver, and not the author, is responsible for

this defect, as we are well aware how difficult it is for an unscientific artist to reproduce on wood the designs of the naturalist. We are not, however, disposed to be critical on a work which has been carried out under circumstances of more than ordinary difficulty, and in spite of physical obstacles with which we Englishmen are happily unacquainted.

THE UNITED STATES COAST SURVEY.*

THROUGH the courtesy of the Smithsonian Institution, at Washington, we have been favoured with the volume containing the Report of the Coast Surveyors for 1861—a year which will be for ever sadly memorable in American annals. The Survey, which was commenced in 1832, had been pursuing its quiet and peaceful labours throughout the whole extent of coast line, extending from Passamaquoddy Bay in the State of Maine, to the coast of Texas in the Gulf of Mexico, and along the coasts of Oregon and California on the western seabord. At various points throughout a line of more than 2,000 miles, small parties were engaged in plumbing the depths, triangulating and sketching the inlets of the coast, bays, and harbours, or determining the Lat. and Long. of conspicuous points. No less than 9,050 of these had already been tabulated, and so steady and undeviating had been the progress made in mapping the coast line, that in eight years (or in 1869) the work was intended to have been completed, when that fatal war which has deluged with blood half a continent, broke out, and at once terminated surveying operations along the whole Atlantic seabord, with the exception of that portion belonging to the New England States. At the stations along the coast of the Southern States some of the property of the department was seized, and the liberty of the officers placed in jeopardy. Two vessels were seized in Charleston Harbour, and a few other slighter losses were sustained; but, on the whole, it may be said that the officers and men made good their retreat, having received instructions to leave their stations whenever the attitude of the State authorities appeared threatening.

It is worthy of remark, that amongst all the naval officers engaged in this department of the public service, not one joined the Confederate cause; and Professor Bache very naturally pays a high tribute to their "loyalty," as many of them volunteered for active naval duty. This, however, only corroborates what has been frequently observed—that at the breaking-out of the war, the Northern side was supreme in the naval arm; while the Southern had the advantage in the superiority of officers for the army. Amongst the naval officers engaged in the Coast Survey in 1861, was Commander D. D. Porter, who recently commanded the two naval attacks on Fort Fisher, and to whose further career the public are looking with some degree of

* 'Report of the Superintendent of the United States Coast Survey for 1861.' Washington Government Printing Office.

interest. Even before the outbreak of hostilities, he appears to have been a marked man, for Professor Bache, on losing his services as superintendent of the hydrographic work of the Western coast, speaks of "the strength of his indomitable will," and pays a high tribute to his "well-known energy and intelligence, which gave large promise of public benefit."

The topography of the coast is now completed along nearly three-fourths of the Eastern seabord of the United States, as they were in 1860, and the hydrography has extended *pari passu*. Of the maps which are published there are three classes. The first is on a scale of $\frac{1}{80,000}$, embracing the coast as far inland as the nearest main road, and a considerable distance at sea. These are highly-finished charts. The second is of a more general character, and on the much smaller scale of $\frac{1}{400,000}$, or about six miles to an inch. These are intended to enable the navigator to recognize the general features of the coast, and they contain soundings to a depth of at least 120 fathoms seaward, as also selected inshore ones, so as to give a general idea of the form of the bottom in bays, estuaries, and harbours. The third class are special charts of harbours, anchorages, &c., on various scales from $\frac{1}{5,000}$ to $\frac{1}{80,000}$ of the natural size, with minute details of soundings, tides, and currents. Besides the above, a new series of charts, planned in 1857 by Mr. Boshke, is in course of construction, by which the whole coast line of the Atlantic and Gulf of Mexico will be portrayed in 32 charts, on a scale of $\frac{1}{200,000}$, or about three miles to an inch. These will be arranged so as to be capable of being mounted in a continuous sheet, and are intended to decorate the walls of public buildings, offices, and dwellings.

During the progress of the Coast Survey, special observations have been made with a view to determining the outline, depth, and other phenomena of that mighty ocean-river, the Gulf Stream, to whose beneficent influence the British Islands are so largely indebted both for the humidity and mildness of their climate. The hydrography of the Gulf Stream is now very generally understood, especially from the writings of Captain Maury, of the Confederate Navy. There is one point, however, indicated in Plate 28 of "The Report," which we do not recollect to have previously observed, and which may therefore have escaped the notice of others; we refer to the position of the axis of the stream with respect to the outer and inner "Cold Walls." The axis (or line of greatest velocity at the surface) occupies a very peculiar position; for it is not, as might perhaps have been expected, in the centre, or even near the centre between the two walls, but throughout its entire length, from near the extremity of Florida to the banks of Newfoundland, it occupies a position from one-third to one-sixth of the breadth of the stream towards the American shore: in other words, it is from three to six times farther from the outer wall than from the inner. Into the causes of this feature in the current of the stream we cannot here fully enter. It is evident, that all along its course till it assumes its easterly direction across the Atlantic, the waters are pent up against the north-western wall. The forces

driving the waters northward are here combined with those carrying them eastward, and on the resulting motion the form of the coast exercises a powerful influence. The general effect is to produce a cross section, similar to that of a river which is bent from the straight course by a bank with a continuous curve.

Notwithstanding the continuance of the war, the Coast Survey is not, we believe, abandoned; but is prosecuting its labours along the New England Coast. No later Report than that we are now reviewing has come into our hands. Since the outbreak of hostilities, the Federal Government has taken good care that documents of such value as coast charts shall not fall into other hands than those for whom they are intended. Consequently, the distribution of copies, which, as authorized by a resolution of the Senate, had amounted to the liberal number of 6,200 up to the year 1860, has been greatly curtailed. For ourselves we need scarcely remark, that whatever our private leanings may be in reference to the two great parties in the struggle, any documents entrusted to our care shall be scrupulously guarded, and the confidence placed in us will not be abused; with this assurance, we hope to be favoured with copies of the later Reports, which will receive the notice they so well deserve.

THE PLURALITY OF WORLDS.*

Amongst our Original Articles in the present Number will be found a Review of the chief scientific facts upon which the believers in the plurality of the habitable worlds base their creed; and if any of our readers should be induced by a perusal of the essay to devote themselves to the study of that important subject, we recommend to their notice the book by M. Flammarion, editor of the Paris journal, 'Cosmos,' of which the title is given at the foot.

We shall presently speak of the merits of this work; but it is partly in consequence of its chief defect that our article has appeared. That defect is the introduction into the argument of an amount of extraneous and, as it appears to us, irrelevant matter, which must materially weaken its force with thinking men accustomed to reason only from well-established scientific data.

To the historical portion of the subject the author devotes nearly sixty pages, citing, it is true, the opinions of many observers whose views may fairly be employed as evidence; but in his anxiety to plead his cause fully, he has given weight to the opinions of heathen writers, which, from their fabulous character, might just as fairly be thrown into the scale of his opponents. Next to this imperfection comes another; namely, the large amount of space which is occupied by

* 'La Pluralité des Mondes Habités, Étude où l'on expose les Conditions d'Habitabilité des Terres Célestes, discutées au point de vue de l'Astronomie, de la Physiologie et de la Philosophie Naturelle.' Par Camille Flammarion, Ancien élève-Astronome à l'Observatoire Imp. de Paris, &c., rédacteur du 'Cosmos,' &c. Paris: Didier & Co.

speculations upon what *may be* the conditions of existence in the other planets, and of this defect the author seems to be well aware; for after dragging his readers through page after page of 'Scientific Romances,' he says*—"Ces digressions s'éloignent un peu trop, en vérité, de l'esprit de cet ouvrage;" and then he proceeds to launch them into "systèmes imaginaires," with a description of which he manages to fill thirty pages more.

Neither does he proceed with the caution that should characterize the discussion of a subject still in the infancy of its history, and he often jumps at conclusions to which every thoughtful man of science must demur. Who, for example, could fail to smile at the author's complacency when he announces as one of the results of the inquiries through which he has conducted his readers,† "L'examen comparatif de l'habitation des mondes a établi qu'une grande diversité de nature règne parmi les hommes des planètes?" Finally he gives us an Appendix of 116 pages, whereof 53 are devoted to the Christian doctrine and its agreement with the one of which he treats; but here he cannot be accused of a want of caution, for he confines himself almost exclusively to reviewing the opinions of others, and a remarkable reason for encumbering a purely scientific inquiry with a mass of sectarian considerations will be found at the conclusion of this portion of his work‡—"Nous ne pouvons cependant nous empêcher de dire, en terminant, que toutes ces discussions métaphysiques nous paraissent superflues et stériles: elles ne sont utiles ni à la gloire de l'Astronomie ni à l'autorité de la Religion." (!) In fact, if all these "superfluous" matters had been omitted, the proportions of the work would have been materially reduced to the great advantage of the argument, for there is little doubt that all the sound scientific information we possess respecting the habitability of the other planets, coupled with everything worthy of being considered as evidence in history and metaphysics, might be compressed into one-fourth of the space devoted to the subject in M. Flammarion's book.

But even the defects to which we have referred are clearly the result of a desire on the author's part to treat his subject with fullness; and there is throughout unmistakable evidence of great conscientiousness in the expression of his own views, as well as in his criticisms of others'. The author's astronomical argument, as might be expected from his position in the scientific world, is posted up to the latest date, and he treats of the possible fertility (and therefore habitability) of the side of the lunar hemisphere which is always hidden from our sight; of the spectral researches into the constitution of some of the heavenly bodies. &c.; but on the other hand, his views upon geological and biological matters must be received with caution, and his observations carefully considered, for on these subjects he does not always exhibit the requisite amount of knowledge.

His thoughtful survey of the present condition of the human race, with its imperfections; his inquiries (conducted in an admirable tone)

* P. 266. † P. 319. ‡ P. 469.

into the dispensations of Providence, and the improbability of this Earth being the only one where creatures exist which partake of the Divine nature, and his treatment of cognate subjects, form as solid arguments in favour of the habitability of other worlds as the physical data that he has collected to prove his point.

He considers the Worlds around us to be stations in Heaven; the regions of our future immortality, if we may be permitted to use the expression. They constitute the Heavenly home of many mansions, and to them he believes his ancestors to have passed; "Nous reconnaissons," he says,* "celui que nous habiterons un jour. Toute croyance pour être vrai doit s'accorder avec les faits de la nature. Le spectacle du monde nous enseigne que l'immortalité de demain est celle d'aujourd'hui et celle d'hier; que l'éternité future n'est autre que l'éternité présente; c'est là notre foi, notre paradis; c'est l'infini des mondes."

Irrespective of the value of this book, as regards its avowed aim of proving the habitability of the other spheres, it will be found useful for the amount of tabulated information which it contains regarding the planets; and the illustrations, which are well executed, will serve along with the text to convey to a young student a very excellent idea of the Solar system.

The language is clear and simple, and in many places it rises to a standard suited to the sublime theme of which the volume treats. We shall be glad to welcome a translation of the work in our own language.

THE CULTIVATION OF QUININE.†

The cultivation of Quinine in Java and British India has been treated of lately by Dr. J. E. De Vrij. The Quinine-yielding trees grow at various heights above the level of the sea in the primitive forests of the contiguous republics of Venezuela, New Grenada, the Ecuador, Peru, and Bolivia. The medicinal properties of the trees have been known from time immemorial to the natives of those countries, but it was not until 1632, that the curative powers of Quinine were known in Europe. The cure effected by the remedy in the Countess de Chinchon, wife of the Viceroy of Peru, brought it into greater notice. The trees were included by Linnæus, in the Genus Cinchona, or, as Dr. De Vrij and others call it, Chinchona. Various species of Cinchona yield the febrifugal alkaloids, Quinine, Cinchonine (Chinchonine), Quinidine, and Cinchonidine. Of these Quinine is the most powerful, and hence the most valued. The species which yields it in largest quantity, is Cinchona Calisaya. Great apprehensions were entertained recently that the trees in South America would ultimately become

* P. 398.

† 'On the Cultivation of Quinine in Java and British India.' By Dr. J. E. De Vrij. late Superintendent of Chemical Researches in Dutch India. London, 1865.

extinct in consequence of being stripped of their bark, and no means being taken to replace the trees which were felled for decortication. The Dutch Government introduced the Quinine trees into Batavia in 1852. The original plant died, but two slips taken from it to Buitenzorg, continued to thrive, and in 1862 acquired a height of 20 feet. M. Hasskarl was appointed to take charge of collecting Quinine plants and seeds for Java. He landed at Batavia on 13th December, 1854, with 21 chests of Quinine plants, and he was entrusted with the management of the plantations. In 1856, he was succeeded by M. F. W. Junghuhn, who died in 1864.

Besides the true Calisaya bark, there were several other species cultivated, and among them a new species which received the name of Cinchona Pahudiana, after M. Charles F. Pahud, Minister of the Colonies, in the Netherlands. The plants were at first propagated by seeds and the process was slow, but Mr. M'Ivor, at Ootacamund, subsequently ascertained that the plants could be much more rapidly and extensively propagated by slips, and this led to a rapid increase. When M. Junghuhn undertook the management in July, 1856, there were 251 living plants, 1,650 slips; but at the end of December, 1863, there were 1,151,810 Quinine plants in the Java plantations, of which 539,050 were growing in the open air, and 612,771 in the sprouting beds and nurseries, besides nearly 7,000 live slips. The plants consisted of:—

Cinchona	Calisaya . . .	12,090
„	lancifolia . . .	251
„	succirubra . . .	89
„	lanceolata . . .	128
„	micrantha . . .	1
„	Pahudiana . . .	1,139,248

These were distributed in plantations varying from 4,440 to 6,830 feet above the level of the sea.

In 1855 an unsuccessful attempt was made to introduce the Quinine trees into British India. In 1859, Mr. Clements R. Markham proceeded to South America in order to procure plants for India. The plants transmitted by him to Ootacamund died, but he made arrangements for the transmission of plants and seeds, which have now been successfully cultivated at Darjeeling, at the foot of the Himalaya; at Hakgalle, near Newera Ellia, in Ceylon; and at Ootacamund, in the Neilgherries. The Darjeeling plantation is under the charge of Dr. Thomas Anderson, superintendent of the Botanic Garden at Calcutta, and in 1864 it contained about 20,000 plants. The Ceylon plantation, 5,200 feet above the level of the sea, is managed by Mr. M'Nicoll, under the superintendence of Mr. G. H. K. Thwaites, Director of the Botanic Garden at Peradenia. At the end of 1863 this plantation contained 22,050 Quinine plants. The plantation at Ootacamund, 7,500 feet above the level of the sea, as well as a branch one at Neddiwuttum, is superintended by Mr. M'Ivor, who has done much by his mode of cultivation to promote the increase of the trees in India. In 1861 there were 172 young plants at Ootacamund, and in 1863 they had increased to 277,083. They were chiefly C. succirubra, or the red bark. An important im-

provement in Cinchona cultivation, introduced by M^c^Ivor. was planting the trees on fully-exposed open spots, and not under the shade of other trees. The woods were cleared away in the first instance, and then the Cinchonas were planted. The effect of exposure to the sun is the production of Quinine in larger quantity, as might have been expected. Mr. M^c^Ivor finds that the young branches supply a bark which yields Quinine. He expects before the end of December, 1865, to forward to Europe between 3,000 and 4,200 lbs. weight of Quinine bark, the yield of 16,000 plants set at Neddiwuttum in September, October, and November, 1862. Dr. De Vrij concludes by giving the following contrast between the Dutch and the English mode of cultivation:—"As the Quinine trees in Java must, according to the present mode of cultivation adopted in that island, be at least thirty years old before they are fully capable of yielding a good quality of bark, I very much doubt whether any capitalists would be found willing to employ their capital in that way for so long a period, and I feel bound, therefore, to answer the question in the negative. The English system, on the other hand, which admits of good interest on capital within four years at the most, and which continues regularly progressing in that respect, is certainly one which prepares the way for the transfer, in due course of time, of the cultivation to private industry."

MICROSCOPIC FUNGI.*

Mr. M. C. Cooke has produced a work on various Microscopic Fungi, more especially those concerned in the production of diseases in plants, which are known under the names of rust, smut, mildew, and mould. These minute organisms are too often passed over as objects of no interest or importance, and even by scientific men they have been sadly neglected. The author remarks:—"Is it not a shame that more than 2,000 species of plants should be known to exist, and constitute a flora, in a nation amongst the foremost in civilization, and yet be without a complete record? It is, nevertheless, true that hundreds of minute organisms, exquisite in form, marvellous in structure, mysterious in development, injurious to some, linked with the existence of all, are known to flourish in Britain without a history or description in the language of, or produced in, the country they inhabit. It is also true that the descriptions by which they should be known, of hundreds more, lie buried in a floating literature where the youthful and ardent student needs not only youth and ardour, but leisure and perseverance unlimited, to unearth them."

The whole number of species of Fungi described in the sixth edition of 'Withering's Arrangement of British Plants,' published in 1818, was 564. In the 'Index Fungorum Britannicorum,' recently printed, there are enumerated 2,479 species. By far the greater num-

* 'Rust, Smut, Mildew, and Mould: an Introduction to the Study of Microscopic Fungi.' By M. C. Cooke. 12mo. Hardwicke: London, 1865. 238 pp.

ber of the species thus added depend for their specific as well as their generic characters, upon microscopical examination. At the present day the British species of flowering plants scarcely exceeds three-fourths of the number of Fungi alone.

Mr. Cooke desires to turn the attention of lovers of science to these minute objects, and to induce them to apply their microscopes in tracing out their structure and mode of reproduction. He illustrates the organic forms and structure of numerous kinds of moulds, and gives coloured representations of them. He refers to the cluster-cups, spores, spermagones, sterigmata, stylospores, and other structures in Fungi, but he fails, we think, in making them intelligible to a mere beginner. The work seems to be rather fitted for one who has acquired preliminary information on the subject. There is a vast accumulation of interesting facts (not, however, always noticed in simple and clear language), and much that is fitted to arouse attention to the subject in hand.

Speaking of the Æcidium of the Goatsbeard, the author remarks:—"If we compute 2,000 cluster-cups as occurring on each leaf, and suppose each cup to contain 250,000 spores, we shall then have no less than five hundred millions of reproductive bodies on one leaf of the Goatsbeard (Tragopogon), to furnish a crop of parasites for the plants of the succeeding year." This gives some idea of the enormous production of germs in these plants. No wonder that they are diffused through the whole atmosphere, ready to fix their abode on any substance where they can find pabulum. The production of mould everywhere depends on the existence of these unseen microscopic germs in the air around us.

Fungi exhibit remarkable changes of form according to the element in which they grow. Hence the diversified forms assumed by Penicillium glaucum, and other kinds of mould when found growing at one time on trees, at another on animal tissues, and at another time on syrup. In speaking of Dimorphism in Fungi, Mr. Cooke points out that the same fungus often passes through two marked conditions —one being the imperfect and undeveloped, the other the fully developed state. "One plant, for instance, sprinkled over the under surface of a rose-leaf, like turmeric powder, has its mycelium or root-like threads (spawn) penetrating the tissue, whilst bearing above its spherical golden-coloured spores. Its vegetative system is complete, and apparently its reproductive also. Hence it seems to claim recognition as a perfect plant, and under the name of *Uredo Rosæ*, was so recognized, until microscopical investigation determined otherwise. Thus it has been discovered that certain dark-brown spots, which appear later in the season, are produced upon the same mycelium, and are indeed aggregations of more perfect and complex fruits of the same plant. Before this point was satisfactorily decided, the brown spores, which are borne on long stalks, and are themselves septate or divided by transverse partitions into a complex fruit, received the name of *Puccinia Rosæ*." Thus, two plants, which he thus referred to different genera, were found to be one and the same species in different conditions.

XUM

"One of the fungal diseases of corn, long and widely known, has obtained amongst agriculturalists different appellations, such as smut, dust-brand, bunt-ear, black-ball, and chimney-sweeper, all referring, more or less, to the blackish, soot-like dust with which the infected and abortive ears are covered. Wheat, barley, oats, rye, and many grasses are subject to its attacks. No one who has passed through a field of standing corn after its greenness has passed away, but before it is fully ripe, can have failed to notice, here and there, a spare, lean-looking ear completely blackened with a coating of minute dust, which comes off easily when touched. Every granule of this minute powder constitutes a spore capable of germination. One square inch of surface contains about 8,000,000 of these spores. The plant which yields this minute gem is the Ustilago segetum, or smut of the standing corn."

The work is rather deficient in lucid order. There is a want of a separate table of contents and of an alphabetical index. The arrangement of the whole work might be improved, and the facts might be so given as to lead a beginner from one step to another until he fully masters the subject. As it is, we fear that many a tyro will be unable to cope with the author, and, while he may carry away a great deal of useful information, yet he will not have acquired a solid standing in the study of Cryptogamic Fungi. The style of the writer is often involved and stiff, and wants the ease which is so essential in scientific treatises. The Appendix contains a classification and description of the Fungi contained in the volume, and an explanation of the Plates. The latter should have been inserted along with each plate in the volume, so as to be more easily consulted by the reader.

PAMPHLET.

For and Against Tobacco.*

The title of this Essay is greatly in its favour, for although enough has been written upon the use of Tobacco, it has all, since King James's well-known "counterblaste," been upon one side, and that the unpopular one; and for the most part it has been written in ignorance and prejudice. But we learn from the present paper that there is also something to be advanced in its favour, and Dr. Richardson's well-known ability, together with the fact that his research is based upon original observation, will cause his opinion upon the debated subject to be highly valued.

The products of the decomposition of tobacco in smoking are by no means constant, but the widest differences prevail arising from differing cigars, differing kinds of tobacco, and differing pipes, although some substances are common to all, as watery vapour, a

* 'For and Against Tobacco.' By Benj. W. Richardson, M.A., M.D. Churchill & Sons.

small portion of free carbon, ammonia, carbonic acid, and a peculiar compound oily product, consisting of a fluid alkaloidal body (nicotine), a volatile substance, and a dark resinous extract. Of these, nicotine is the last to exert any effect upon the smoker. The first impression of tobacco smoking is made upon the blood, which rapidly circulating, conveys it to the more vascular organs, and the stomach is the first to give indication of suffering, and there under ordinary circumstances the matter ends. If, however, it be continued beyond that point, the brain and nervous system next become affected; and, pushed farther, death ensues from arrest of the beating of the heart. Tobacco, however, is *not a narcotic*, nor has it any of the seducing effects of a narcotic at its first trial, but becomes milder as it grows more familiar, *a tolerance* being set up such as is the case with many other poisonous substances, as antimony, &c. The products of tobacco find a ready exit from the system, by the lungs, skin, and kidneys. Hence the ammoniacal breath of every heavy smoker, and the smell of the clothes, partly due to the vapour which is exhaled through the skin, while the nicotine and bitter extract are carried out entirely by the kidneys. The effects, therefore, are transitory, and the influences exerted are functional, not organic.

What, then, is the nature of these transitory functional disturbances of the blood, stomach, heart, nervous system, and glands of the throat and mouth? This subject next engages the author. He finds the blood thinner than natural, and in extreme cases, paler; the corpuscles lose their round shape and become oval and irregular, but rapidly recover their normal condition when the cause is removed, while free imbibition of fluid, during prolonged smoking, increases these derangements. Upon the stomach, the effect is to impair appetite by diminishing the oxidation of the body, and so preventing waste. The mucous membrane and the muscular layer are both affected, the former by the bitter extract, the latter by the nicotine. These substances both travel along the stem of the pipe, and are absorbed directly into the mouth, so that while a long, perfectly clean clay pipe, which easily absorbs them, may be smoked with impunity, only the confirmed smoker can tolerate the black, dirty bowl and stem, and in proportion as the toleration is borne, the digestion is sacrificed. So, also, some tobaccos, as cavendish, pigtail, and shag, yield these products much more abundantly than Latakia or Turkish, &c.; while cigars, if they are "good," produce dyspepsia very quickly; for in smoking them, unless a long mouthpiece be used, nicotine is inevitably absorbed. With regard to the heart, there is no evidence to show that tobacco causes any structural change, but Dr. Richardson is of opinion that in persons strongly disposed to rheumatism or gout, tobacco is rather a preventive of structural change, and also that in persons subjected to an unnatural degree of muscular exercise, a pipe daily is beneficial rather than otherwise. Moreover, tobacco has a tendency to counteract the serious organic diseases dependent upon the acid modifications of the blood due to excessive imbibition of alcohol.

The effects produced upon the eye appear to be dilatation of the pupil, and in extreme cases amaurosis, due to the absorption of

XUM

nicotine; upon the ear, confusion and inability to appreciate distinctly sounds that are either very soft or unusually loud; with occasional sharp ringing in the ears; and it is probable that after long smoking both smell and taste may, to a certain extent, be impaired; but the rule is not general, though snuff-taking does destroy the sense of smell. With regard to its effects upon the mental faculties, most contradictory statements have been made, it being too often inferred that because certain symptoms occur in persons that smoke, *therefore* those symptoms are due to the tobacco, and to nothing else. That it tends to produce insanity, without predisposition, Dr. Richardson firmly denies, and even where predisposition is present, he believes that the damages committed by tobacco are fully and even more than met by the advantages which occasionally follow. As a rule, the mischief produced upon the nervous system is transient and evanescent.

Can smoking excite locally—as in the lips, tongue, or throat—the disease cancer? To this the author replies that he has never met with a single instance in which tobacco smoke could be said to have brought on the acute disorder; and epithelial cancer of the lower lip appears to be due, not to the tobacco, but to the mode of smoking it—*viz.* in short pipes, which press habitually upon the lip. It does not become developed in cigar smokers, nor in those who smoke long smooth pipes.

Neither consumption nor chronic bronchitis can be produced primarily by smoking, but the indirect effects are harmful to those in whom the disease is developed. and the author insists on every consumptive patient yielding up the pipe or cigar, and has found a rigid adhesion to this rule worth many a formal prescription.

Dr. Richardson's essay is impartial and philosophic, his results often at variance with popular and established principles, which, however, have only imperfect information as their basis; and as is generally the case, a careful weighing of the evidence gives strong reason to believe that the use of tobacco is not wholly good, nor wholly bad; but that, at all events in our artificial mode of life, there are conditions in which the weed, by some despised, by some worshipped, may be of real service.

NOTES AND CORRESPONDENCE.

Reform in the Committee of Council on Education, and the Science and Art Department.

THE appearance in our last Number of the article on the Science and Art Department, has brought us many painful expressions of approval, both from the Press and from individuals who have suffered from the mismanagement at South Kensington. Newspapers have been forwarded to us from Exeter, Plymouth, Glasgow, &c., with articles complaining bitterly of the injury done to local institutions, and expressing a fervent hope that there might soon be Parliamentary interference in the matter.

From Science teachers, too, we have received communications — some conveying a desire to form a defensive association, others expressing fear lest such a movement might prejudice them still further with the State.

In one case, the friend of an ex-teacher forwards to us a statement of the history of the teacher's connection with the "Department." As it fairly represents the working of the whole system, and the teacher is well known to us by reputation, as one of the most successful (if not *the* most successful) of the whole body, we do not hesitate to publish it as received :—

"He began his courses of instruction in 1860 ; the money received by him as the result of that year's teaching was, in round numbers, 130*l.*; the next year it increased to 170*l.*; the year after to 230*l.*; and in 1863 to 250*l.* Then the influence of the Revised Code was felt; the result being that, with about the same number of pupils, of the same average capacity as those of former years, the teacher's earnings at once fell to 90*l.* He saw at once—in fact, he could not help seeing—that it was now utterly useless to expect to earn a livelihood by teaching Science under the auspices of the Committee of Council on Education, and although he had spent several of the best years of his life in qualifying himself for that work, he was reluctantly but imperiously compelled to relinquish the duties he had discharged so successfully."

This statement (which, as we have already observed, is typical of the working of the system, for we know other excellent men who have suffered in a similar manner) does not represent the whole hardship of the case, and delicacy for the feelings of scientific men, so little considered by the authorities at South Kensington, prevents us from publishing further details.

We must now wait patiently for the results of the inquiry into the "constitution and procedure of the Committee of Council on Education," undertaken by the Select Committee of the House of Commons, moved for and obtained by the Right Hon. Sir J. Pakington, and we have great confidence in the fairness of such an investigation; for, although it is impossible to guard against the introduction of abuses into any department of the State, and to prevent maladministration and an unwise employment of public moneys, we feel sure that, whenever a number of honourable English statesmen set themselves earnestly to work to correct an abuse which *has* been laid bare, they will not leave their work incomplete.

The "Select Committee" is, in this case, entitled to the cordial co-operation of every person connected with Science instruction in the three kingdoms, and we earnestly appeal to all persons who desire that the State should be at least as honourable in its dealings as are private

XUM

individuals, to lend the movement their utmost support.*

Sir John Pakington was right when he said that great dissatisfaction prevails throughout the country with the administration of that section of the Government which is supposed to consist of a number of cabinet ministers, but which is practically represented by two or three heads of departments, or more properly speaking Government officials. It is not Lord Palmerston, nor Mr. Gladstone, nor any other minister, who manages the Educational Department of the State — it is Mr. Lingen and Mr. Cole.

Of the former we know but little, excepting that he appears to be no greater favourite with the Science and Art Department than he is with the country. Of the latter we perhaps know a little more. He loves art, takes a great pride in the South Kensington Museum, upon which he is permitted to expend vast sums of money, which should, if the engagements of the State were honourably fulfilled, be paid to Science teachers for work done; and he is heard of by the committees and managers of Science schools about as frequently as they hear of the "Lord President." Nay, let us not be unjust to his lordship—not so often. During the last four or five years we have seen every protocol, and every "form," issued by the Department, and we never recollect to have observed the signature of Mr. Henry Cole to one of them. Sir John Pakington is right, then, when he says that there is no responsible head to the Education Department, and it is easy to conceive the confusion which must exist under such a state of things—the little fracas which must arise between the departments as to the disposal of the public funds. We have good cause for believing that, after the appearance of the Revised Educational Code, the Science and Art Department had to struggle with the Education Department for its very existence. It escaped being choked to death, but its life-blood is ebbing fast.

One of the speakers, on the motion for a select committee, stated that the inquiry now being instituted would merely have the effect of showing the excellent system of management adopted by the Committee of Council on Education, whilst another, holding similar views, remarked that it would simply cause persons with grievances to pour them into the ears of the committee. We can hardly reconcile one statement with the other, but doubtless the second will be found to be correct.

No doubt every means will be taken to make matters look as pleasant as possible in the happy families at South Kensington and Whitehall, but we trust that the loud complaints which will not fail to reach the committee will open their eyes, and cause them to enter upon a searching investigation of the actual state of the case. We hope that the Committees of Management, who not only work gratuitously themselves, but pay those persons whom they entrust with the central authority (a fact which seems to be quite overlooked by the officials in receipt of fat salaries)—we hope that these will come forward and lay a correct statement of the working of the various departments before the committee, and that they will petition for a reformed management of the whole section of the State. That it is their duty towards those whom they engaged, relying upon the good faith of Government, to do the work of Science teaching, there can be no doubt, and it is equally true that they owe this to the numerous young students upon whom they have hitherto been the means of conferring "a little knowledge," but who, under the present system, will soon be thrown entirely upon their own resources.

* The Select Committee consists of Sir John Pakington, Mr. Bruce, Mr. Walpole, Viscount Enfield, Lord Robert Cecil, Mr. William Edward Forster, Mr. Adderly, Mr. Clay, Mr. Howes, Sir Colman O'Loghlen, Mr. Walter, Mr. Thompson, Mr. Stirling, Mr. Buxton, and Mr. Liddell.

On the Connection between the supposed Inland Sea of the Sahara and the Glacial Epoch. By Rev. HORATIO J. WARD, M.A.

A LARGE number of our most eminent geologists appear to have given in their adhesion to the theory, that the Glacial Epoch was coincident with the period during which the Sahara of North Africa formed the bed of an ocean or vast inland sea. Many, I believe, consider further, that these physical conditions so different to existing ones, were not merely coincident, but were closely connected as cause and effect, that is to say, that the phenomena of the Glacial Epoch may (to a certain extent) be accounted for, by the fact of the existence during that epoch of an expanse of water, where now is to be found only one of sand.

It would be needless for me to dwell on the facts and reasons by which this theory is supported, for by this time they must be tolerably familiar to most of the readers of this periodical; but so far as I am acquainted with what has been written on the subject, only the *immediate* and *direct* influence which the former of these two physical states exerted on the climate and temperature of Southern, Western, and Central Europe has been touched upon; whereas it appears to me that the *in*direct influences must have been far greater and more widely felt.

It is upon these latter, then, that I wish to broach a few ideas, trusting that some of your wiser readers will enlighten me if I am wrong, or pursue the subject in your pages, if so far I should be found right.

My argument compels me to mention first, some well-known and common-place facts.

Everyone now-a-days is aware that the warm climate of Western and North-western Europe is owing to the Gulf Stream; but it is *not everyone* who knows what are the causes of this great current. Subsidiary causes there may be, but undoubtedly the main one is, the North-east trade-wind, blowing incessantly, and with considerable force, in the Atlantic from a few degrees north of the equator to about the 27th or 28th parallel. The effect of this steady pressure, all in one direction, over so enormous an expanse of water may be imagined by those who have at all paid any attention to such subjects: there is an abnormal elevation of the water on the North-east coast of South America, to the height of (I believe it has been calculated) thirty feet. Literally, we have the "Atlantic Steep," of Thackeray's well-known verse. This enormous accumulation of water streams off northwards, until, released from the pressure of the trade-wind, but still retaining its northern impetus, it trends to the North-east—towards our own shores, Iceland, and even Spitzbergen.

This slight outline will suffice to show how the N.E. trade-wind is the moving cause of the Gulf Stream; and now I hasten to the next link in the chain of cause and effect. What causes the N.E. trade-wind?

Most geographers, I believe, will reply without hesitation, "Mainly the Sahara," but let us see how. The air throughout the whole of the tropics being heated, and thus rarefied, ascends into the higher regions, and its place is supplied by the colder atmosphere streaming in from north and south. This simple statement, however, requires, of course, many modifications. I must confine myself to two immediately connected with our subject. The first is this. As the air streams in from the Arctic regions where the velocity of the earth on its axis is small, to the tropical regions where it is considerable, it is obvious that the motion of the earth from W. to E. being only *partially* communicated to the air, the latter will be left behind as it were—that is, there will be an apparent motion in it from E. to W.

in those parts of the earth's surface towards the equator. *North* of the Line, then, this westerly direction of the wind, combined with the southerly direction spoken of before, gives, (by the well-known mechanical principle of the parallelogram of forces,) as a resultant, a direction of the wind from the N.E., this is the trade-wind of the North Atlantic. But next, let it be observed, this wind owes almost all its force to the fact of the enormous radiation of heat from the surface of the Sahara, causing a prodigious rarefaction in the atmosphere above it—hence a vehement impetus is given to the current of air traversing it from the N.E.; that is to say to the wind, which, as we have seen by its action on the waters of the Atlantic, is the main cause of the Gulf Stream.

Suppose, then, the Sahara to be an expanse, not of *sand*, as now; but, as formerly, of *water;* what would be the results?

Much that of the old nursery story—"Water won't quench fire, fire won't burn stick," &c.—the trade-wind would cease, or be so reduced in strength as to exert but slight pressure on the surface of the Atlantic; then, as a consequence, the Gulf Stream would either cease or shrink into insignificant dimensions; the icebergs from Greenland, instead of being melted by the heated waters far towards the north, would encroach more and more southwards; the seas round our own islands, and (*à fortiori*) those more to the north, would again present the spectacle of an Arctic or sub-Arctic climate, at least as severe as that of Labrador in the same latitude: in short,

——"grave rediret
Sæculum,"

the phenomena of the Glacial Epoch would be renewed over the greater part of temperate Europe.

My letter is longer than I had intended it to be, though I have rather indicated than expressed many points of my reasoning, and have strictly avoided all collateral issues. May I venture to hope that some abler pen will take these up, and thoroughly ventilate the whole subject.

H. J. Ward.

Bridgnorth, 11th March, 1865.

The New South Wales Coal Fields. From Mr. John Mackenzie, Government Examiner of Coal Fields, New South Wales.*

Since I last wrote to you, and within six weeks, I have had two long and tedious exploring journeys. In the first trip, I rode in about ten days upwards of 300 miles over a very rugged country, going in one place over a barren sandstone country thirty-five miles in length. I left here with my man and three horses, one horse being the *pack horse*—that is, it carried the provisions, panakins, blankets, pick, saddle-bag, &c., and a piece of oil-skin, with some calico stuffed with sea-weed for me to lie upon. I went for the purpose of seeing whether the *Hartley coal* seams in the county of Cork belonged to the same coal basin as Newcastle and Wollongong (*see* plan of New South Wales), and to see if I could find out with which known seams of coal on this side they were identical. I was able to recognize them. Another reason for my going was, that I had an idea that I could find coal identical with the Fitzroy coal at a distance of thirty miles from Sydney (the metropolis of New South Wales). The route

* This communication reaches us through the courtesy of a correspondent in England, to whom it is addressed (not to the Editors). Our readers will, we believe, be glad at all times to peruse similar authentic records of the progress of scientific discovery abroad.—*The Editors.*

by which I wanted to come and return home to satisfy myself if coal existed there, I was told was uninhabited, and that I could not find it without a guide; so I engaged a black fellow, and a tremendous journey we had of it. I have satisfied myself that coal will be there, but must examine another place before I can tell whether there is a good seam of coal. I have found the lower coal, which is inferior, and cannot yet tell whether it will be near enough from the edge of the coal basin for the next excellent seam of coal to come in above it. The coal *measures* I find gradually increase in their thickness from the edge of the coal basin towards the centre of it. and the Sydney or Clarkes Hawkesbury sandstone rests on the coal measures near the edge of the basin, whilst near the centre of it, it is 900 feet from the top, coal sandstone and shales of a different nature to the Hawkesbury sandstone intervening in the 900 feet; and it has always been supposed by other geologists that it would always be 900 to 1,000 feet from the Hawkesbury sandstone to the first coal, whilst I am certain that I can find it only thirty miles from Sydney at a depth of 150 to 200 feet; but if I go to twenty-eight miles, and find the top coal coming in, it might be 400 feet.

The last journey was one of the worst I ever had, and I am now suffering with a touch of rheumatism in my leg from it. The first day we went fifty miles on horseback in a hot wind, and the next day forty-five, arriving at Windsor. Went from there to Richmond, up the river Grouse, towards the boundary of the county of Cork. It is considered about one of the worst places in New South Wales to travel. We tried to take horses up it, but after cutting their feet, we sent all back but the pack-horse, and after going six miles up, we had to leave the pack-horse tied to a tree, take our provisions and a blanket, and crawl over and under logs, and jump from stone to stone. Well, about 7 P.M. that night, we lighted a fire in a most dismal and uncomfortable place, had our *beds* made of hard sandstone, with a few rushes and ferns cut and thrown over it, and a ledge of a rock to shelter us. The river having rocks on each side of it 500 to 600 feet high. To our horror, at 3 A.M. it commenced to rain, and we held a consultation whether we should go farther up the river to seek the coal, and dry our clothes at the fire at night, or return. Well, we decided to go on, and after going about four miles, which took us *five hours*, and finding the river getting more impassable, we thought we could not possibly get to the coal in one or two days; and as we were wet through to the skin, we decided to retrace our steps. When we reached the horse, we found that he had got frightened, and cut his knee; and when we came to take him home, we wondered how we had brought him so far, and thought he would have killed himself; and we have partly ruined him. It was very lucky for us that we just managed to get to a house when quite dark, or I should have had a worse touch of rheumatism than I now have. I little thought when I used to see the gipsies at Aspull Moor that I should ever go about in that way. I was going home when it cleared up, so I thought I would go up another river, which proved to be ten times worse than the previous one, and although we only went eight miles up it, and wished to return that way, we preferred walking forty miles round to going the eight miles to where we had left our horses. The man I had with me being an Irishman, and not used to such journeys, got very surly when he saw me going up different hills, and I had to give him a little of my mind about it; and the riding made him very sore. The day we were so wet, I was

ahead, and he kept calling out, "Hold; I am so wet, I can hardly walk."

You know what it is to walk under fern *trees* laden with rain.

I will just give you an outline of what I know from my own explorations of this vast coal-field.

I have explored the counties of Camden, Cumberland, Cork, Hunter, Northumberland, and Durham, and find that the New South Wales Coal Basin extends under the whole of them, and a portion or the whole of Gloucester (I have not explored the whole of it), a portion of the counties of Brisbane (*not Brisbane, Queensland*), Phillip, Roxburgh, Westmoreland, and St. Vincent, and that the south-easterly and north-easterly side of the coal basin lies partly buried under the Pacific Ocean, and principally washed away, which makes the New South Wales Coal Basin at least 200 miles in length, and probably the same in breadth; but the breadth can never be ascertained, owing to the easterly side of the basin being in the Pacific Ocean. I know this will interest you. * * * *

JOHN MACKENZIE.

On the Iron-bearing Deposits of Oxfordshire. By E. Hull, B.A., F.G.S.

IT is not very generally known that there are considerable tracts of iron-bearing deposits in Oxfordshire, which, when this generation shall have passed away, may be the means of converting this rural and quiet district into a second Middlesborough. This we say advisedly, for, with some geographical differences which will occur at once to every mind, the geological and mineral features of the two regions are similar. Middlesborough and Teeside generally, have advantages in their proximity to the coast for export trade; in being less distant than Oxfordshire from the coal districts, and in having less competition with iron ores from the coal districts of the north of England themselves. For the present, therefore, and for many years to come, the favoured region of Cleveland must hold its own; but it is well to know that when the process of exhaustion in this and other centres of production shall have been completed, other regions are lying in wait to step in and recruit the ranks of trade.

It is time, however, to come to the subject of the geological age and mineral character of the Oxfordshire ores. Strictly speaking, there are three iron-bearing formations in Oxfordshire, but only one of any importance whatever. The highest of these, in the geological scale, are the silicious ores of the Wealden—or Lower Greensand formation (for it is doubtful to which of these groups the beds belong), which are found on the highest parts of Shotover Hill, near Oxford. Here there is a considerable quantity of dark silicious ore, apparently tolerably rich, and only made use of for building walls and similar work. The limited extent of this rock, and its inaccessible position (speaking commercially), render it of no intrinsic value, and only to be treated with consideration from the fact that it contains, in some places, a remarkable group of fresh-water shells.

The next iron-bearing formation in descending order is the Great-Oolite. The basement beds of this formation, when traced from Oxfordshire into Northamptonshire, are found to become gradually more and more silicious, and eventually merge into the "Northampton sands." These yellowish sands (which stratigraphically represent the Stonesfield slate series, a "lower zone of the Great Oolite") become, in certain places, calcareous; in others, ferruginous; and thus pro-

duce, both in Oxfordshire and Northamptonshire, a silicious iron ore capable of being worked. In the former county, however, we only know of one spot where it is of any commercial value—we refer to the village of Steeple Aston, near Deddington; but even here we should infer, from the character of the ore, that it would be capable of producing only exceedingly brittle iron. Having thus briefly disposed of these unimportant ores, we now proceed to the third, and the only commercially valuable iron ore in Oxfordshire—this is the rock of the Middle Lias, or Marlstone.

This remarkably persistent rock, extending as it does from the south coast of England, through Somersetshire, Gloucestershire, Oxon, and Northamptonshire, to the Yorkshire coast, though never of greater thickness than twenty or twenty-five feet, and often less than a third of that amount—is, in certain places, a calcareous sandstone; in others, a valuable ironstone. Under the former character, it may be traced along the western flanks of the Cotteswold range of Somersetshire and Gloucestershire, often jutting out from the sides of the hills in the form of terraced or tabulated banks, subsidiary to the main ridge. In this district, however, it is never an ironstone, but a highly calcareous sandstone, crowded with characteristic fossil shells. On being traced, however, into Oxfordshire and the neighbouring districts to the north-eastward, it becomes more or less impregnated with iron, till it assumes the character of a nidious peroxide or carbonate, with a proportion of metal varying from 20 to 40 per cent. The rock rests generally on certain sandy shales, more or less pervious to water; and is surmounted by the blue clays and shales of the Upper Lias, which separate it from the Great Oolite. The thickness of these shales varies from 20 feet at Fawler, near Charlbury, to about 120 feet in the neighbourhood of Banbury, and they often form sloping grassy banks, rising above the terraced surfaces of the Marlstone rock. In the Cleveland hills, the iron-bed occupies a precisely similar geological position, underlying the blue shales of the Upper Lias, which are about 150 feet in thickness, and are in turn surmounted by the freestone of the Great Oolite, which forms the crest of the hills.

In both districts the mineral character of the ore is very similar. In the hills overlooking the estuary of the Tees, the ore, when hewn fresh from the interior of the hill, is of a greyish-green colour, and very solid, but gradually passes, on approaching the surface, into a rusty and somewhat concretionary stone, due to oxidation and weathering. In Oxfordshire, the rock assumes a deep olive-green colour, and under the lens, shows an Oolitic structure; on exposure, and at the surface, it also becomes rusty and somewhat concretionary; and in both cases, when calcined, it assumes a red colour resembling earthy hæmatite. In the Cleveland hills, however, the ironstone rock appears to be more persistent and uniform in mineral character than in Oxfordshire.

The ore occurs, and was first discovered at Fawler, near Charlbury, about six years ago, on the property of the Duke of Marlborough, along the line of the West Midland Railway. Considerable quantities have been sent into South Staffordshire, but owing to the depressed state of the iron trade, it is not, we believe, being worked at present. The rock is here about 12 or 15 feet in thickness, nearly uniform in character throughout; but in some places somewhat calcareous. An analysis made by Dr. Percy, at the Museum of Practical Geology, gave an average from nine samples of 32 per cent. of iron, and of phosphoric acid only a trace. For flux-

ing it requires 10 cwt. of limestone to the ton of iron, and taking the price of coke laid down on the spot at 15*s.* per ton, it has been estimated that the cost of smelting pigs, including royalties, labour, &c., would be about 2*l.* 12*s.* The carriage into South Staffordshire would be, in addition to the above, 3*s.* per ton.

A more extensive district, and one which also possesses the advantage of yielding the ore over a large surface without any cover, occurs to the west and south of Banbury, extending as far as the village of Hook Norton. Railways are already projected over this tract, occupying an area of perhaps 25 square miles; and visions of furnaces rising amidst the church steeples and farmsteads of this hitherto unsophisticated region are floating before the minds of some of the residents. For ourselves, we look upon this as reserve ground, not likely to be opened up for many years. But who shall venture to say what may or may not happen with the mines of the Cleveland hills, and furnaces of Teeside blazing away before our eyes, where all was silent and motionless a few years since?

E. Hull.

On the Occurrence of a Tertiary Species of Trigonia in Australia.
By H. M. Jenkins, F.G.S.

The very interesting discovery of a species of *Trigonia* in the Tertiary deposits of Australia has in England remained entirely in the background, and I have been several times surprised at finding students of Tertiary palæontology, generally *au courant* with the progress of their special branch of science, unacquainted with the circumstance. Its importance, in a theoretical point of view, is beyond all question, hence the deep interest always exhibited by those to whom I have spoken on the subject. I trust that it will also justify my bringing forward in your Journal a subject not quite new, although very nearly unknown.

On the Southern Coast of Australia is a series of Tertiary deposits of vast extent, the exact age of which is somewhat doubtful. Certain portions are said to be older than others, but their palæontology has not been sufficiently studied to enable one to speak very definitely on the probable correctness of this view. The older beds have been called Upper Eocene by Professor M'Coy, and the younger Lower Miocene. But an examination of a collection from the beds of Muddy Creek, sent over by the Rev. Julian E. Woods, and marked "Eocene," induced me to believe that the shells contained in the collection indicated a Miocene, or even later age (using the term Miocene conventionally), and were allied partly to the recent Philippine fauna, and partly to European Miocene species. There is great difficulty in correlating Tertiary deposits so far away with those of Europe; but as Dr. Duncan has since published an opinion very similar to that just stated, founded on the Corals and Echinoderms, and Professor Rupert Jones is also inclined to the same view, from an examination of the Foraminifera, I think we cannot be very far wrong. Hence we may consider the *Trigonia* to which I have referred as being doubtfully Miocene, perhaps newer, its age being well enough defined by the Austrian term Neogene, which includes both the Miocene and the Pliocene.

The newest species of *Trigonia*, with the exception of the recent

ones and that in question, occur in Cretaceous rocks. The genus is pre-eminently Jurassic, but extends upwards into the chalk. Everyone knows that the Jurassic Mammals are very nearly related to the Marsupials of Australia, and that this curious relation has been used by geological theorists, much as the unfortunate frog has been tortured by experimenting physiologists. It is also well known that the Jurassic facies of the Australian terrestrial fauna is strengthened by the existence of three or four species or varieties of *Trigonia* in the neighbouring seas. But matters seem to have reached a climax, now that in the Tertiary beds of the same great island there has been found a *Trigonia* which is much more nearly related to the Oolitic than to the recent species, for it belongs to the same type as the former, and to a different one than the latter.

The recent species have radiating ribs commencing at the umbo, and proceeding straight to the margin; they belong to the "pectinate" division of the genus, and indeed entirely constitute it. The Tertiary species, which has received the name of *T. subundulata* from Professor M'Coy, though it has never been described, belongs to the "costate" group, which is mainly represented in Jurassic rocks, but a few species of which pass up into Cretaceous strata. The chief characteristic of this group is that the anterior portion of the shell is ornamented by longitudinal ribs, which stop short where they meet the keel, extending from the umbo to the lowermost of the three posterior angles, from which the genus derives its name; behind this the ribs are nearly vertical, that is to say, parallel to the keel, and nearly at right angles to the longitudinal ribs already mentioned. In this chief feature *Trigonia subundulata* resembles all the species of the "costate" section, coming nearest, perhaps, to *Trigonia suprajurensis*, Agass.; but it should be mentioned that the keel is not so prominent as in other "costate" species, being scarcely more so than the rest of the ribs.

Every palæontologist believes that, when a genus of animals is represented by species occurring in strata of widely different ages, it must have been perpetuated by some one or more species during the whole of the intervening period. In fact, it is generally assumed that a genus or a species never reappears after it has once died out, and palæontologists feel as certain of the truth of this postulate as of that of the first axiom in Euclid. The same law would generally be allowed to hold as good for families, orders, and classes, as for species and genera.

It seems paradoxical that the most ardent admirers of the "final cause" line of argument, as opposed to the empirical, should be the most strongly opposed to an application of their practice to this curious subject; but such appears to be the case. The reason is obvious. The only rational *meaning* that has ever been attached to this presumed general law (for it is incapable of proof in many cases) is, that the perpetuation of the genus, species, family, &c., as the case may be, has been due to "descent with modification." The accident of the intermediate links being unknown in such cases, when everyone believes them to have existed, supplies an excellent parallel to the frequent absence of the fossil remains of the "connecting links" between groups of animals, especially as this absence has so frequently been a stumbling-block in the path of the students of Mr. Darwin's theory. The absence in the one case appears to be due to the same causes as in the other; and if the want of evidence be not incompatible with former existence in the former, neither is it in the latter.

Trigonia subundulata is one of the links hitherto wanting; first, in ex-

planation of the existence of the genus *Trigonia* in the Australian seas of the present day; and secondly, as showing that the great gap which before existed in its life-history was no proof of the falsity of the postulate of palæontology to which I have referred, but was simply a consequence of the imperfection of our knowledge of the geological record; for, though the record itself is imperfect enough, our knowledge of it is still more so. The discovery of this *Trigonia* also gives strength to the comparison of the recent Australian fauna with that of the Jurassic period in Europe, and supplies those who do not believe in the exact synchronism of distant formations containing similar fossils, with an excellent illustration of their views.

Books received for Review.

From *The Smithsonian Institution, Washington*:—

BIBLIOGRAPHY OF NORTH AMERICAN CONCHOLOGY, previous to the year 1860. By W. G. Binney. Part I. American Authors. Part II. Foreign Authors.

RESULTS OF METEOROLOGICAL OBSERVATIONS made under the direction of the United States Patent Office and the Smithsonian Institution, from the year 1854 to 1859 inclusive: being a Report of the Commissioner of Patents, made at the first Session of the 36th Congress. Vol. II. Part 1. Washington: Government Printing Office, 1864.

MONOGRAPHS OF THE BATS OF NORTH AMERICA. By H. Allen, M.D., Assistant Surgeon, U.S.A. Woodcuts.

THE GRAY SUBSTANCE OF THE MEDULLA OBLONGATA AND TRAPEZIUM. By John Dean, M.D. 15 Photo-lithographs and Copperplate Engravings. 4to.

RESEARCHES UPON THE ANATOMY AND PHYSIOLOGY OF RESPIRATION IN THE CHELONIA. By S. Weir Mitchell, M.D., and George R. Morehouse, M.D. Woodcuts.

RECORDS AND RESULTS OF A MAGNETIC SURVEY OF PENNSYLVANIA AND PARTS OF ADJACENT STATES IN 1840 AND 1841, with some additional records and results of 1834–5, 1843, and 1862. And a Map. By A. D. Bache, LL.D., F.R.S., &c., &c.

DISCUSSION OF THE MAGNETIC AND METEOROLOGICAL OBSERVATIONS MADE AT THE GERARD COLLEGE OBSERVATORY, PHILADELPHIA, 1840 to 1845 inclusive. Second Section. Ditto, ditto, Third Section. Same Author.

METEOROLOGICAL OBSERVATIONS IN THE ARCTIC SEAS. By Sir Leopold McClintock, R.N., made on board the Arctic searching yacht 'Fox,' in Baffin's Bay and Prince Regent's Inlet, in 1857–8–9. Reduced and Discussed by Charles A. Schott, Ass. U.S. Coast Survey. Map and Woodcuts.

ANCIENT MINING ON THE SHORES OF LAKE SUPERIOR. By Charles Whitterley.

ON THE CONSTRUCTION OF A SILVERED GLASS TELESCOPE FIFTEEN-AND-A-HALF INCHES IN APERTURE, AND ITS USE IN CELESTIAL PHOTOGRAPHY. By Henry Draper, M.D., Professor of Natural Science in the University of New York. Woodcuts.

From *Messrs. Longman & Co.*:—

HEAT CONSIDERED AS A MODE OF MOTION. By John Tyndall, F.R.S., Professor of Natural Philosophy at the Royal Institution, &c. 2nd edition. With Engravings.

COSMOGONY; OR, the Principles of Terrestrial Physics. By Evan Hopkins, C.E., F.G.S.

RAILWAYS: a Plan for the Systematic Reform of the Railways of the United Kingdom by Legislative Enactment.

From *Messrs. Harrison*:—

HOW TO WORK WITH THE MICROSCOPE. By Lionel S. Beale, M.B., F.R.S., Professor of Physiology in King's College, London. 3rd edition. 56 Plates. 288 pp. Demy 8vo.

From *Messrs. Virtue Brothers*:—

A TREATISE ON LOGIC, PURE AND APPLIED. By S. H. Emmens, Esq.

From *Messrs. Baillière & Fils, Paris*:—

TRAITÉ THÉORIQUE ET PRATIQUE DES MALADIES DE L'OREILLE ET DES ORGANES DE L'AUDITION. Par le Dr. J. P. Bonnafont. 576 pp. Demy 8vo.

XUM

From *M. Oudin, Poitiers*:—

Essai sur la Médication Isolante: ou traitement des inflammations en général par les enduits imperméables, avec des observations cliniques à l'appui; suivi de quelques considérations sur la nature et le traitement de la fièvre dite puerpérale. Par le Dr. F. Benoist, Lauréat de l'Ecole de Médecine de Poitiers.

From *Mr. Effingham Wilson*:—

Philosophical Papers. By N. A. Nicholson, M.A. Trin. Coll., Oxford.

From *Mr. Bernard Quaritch*:—

The Life, Times, and Labours of the Second Marquis of Worcester: to which is added a Reprint of his Century of Inventions, 1663, with a Commentary thereon. By Henry Dircks, Esq., Civil Engineer, &c. With Engravings. 650 pp. Demy 8vo.

From *Mr. Van Voorst*:—

A Treatise on the Construction, Proper Use, and Capabilities of Smith, Beck, and Beck's Achromatic Microscopes. By Richard Beck. 28 Plates and 76 Woodcuts. 140 pp. Royal 8vo.

PAMPHLETS.

Memoirs of the Geological Survey of Great Britain: The Geology of the Country between Folkestone and Rye, including Romney Marsh. By Frederick Drew, F.G.S. List of Fossils by R. Etheridge, F.R.S.E., &c.

Observations on the Functions of the Liver. By Robert McDonnell, M.D. (Dublin: Fannin.)

Catalogue of Minerals, with their Formulæ, &c. By T. Egleston. (Smithsonian Institution, Washington.)

Instructions for Research relative to the Ethnology and Philology of America. By George Gibbs. (Smithsonian Institution, Washington.)

Address of the President of the Royal Astronomical Society, for the year 1864-5, Warren De la Rue, Esq.

Address of the President of the Entomological Society of London, for the year 1864-5, F. P. Pascoe, Esq.

A Companion to the Weather-Glass, designed to record, numerically and graphically, the Natural Phenomena presented by the Barometer, Thermometer, Rain-Gauge, Clouds, Wind, &c. With a Calendar for the year 1865. By a Meteorological Student. With Plates and Engravings. 70 pp. Post 8vo. (Bemrose & Sons.)

The Irrationale of Speech. By a Minute Philosopher. Reprinted from 'Fraser's Magazine' for July, 1859. 33 pp. Demy 8vo. (Longman & Co.)

Philosophy of Religion. By Hugh Doherty, M.D. 48 pp. 8vo. (Trübner & Co.)

On the Introduction of Cavern Accumulations. By William Pengelly, F.R.S., &c.

On the Denudation of Rocks in Devonshire. By William Pengelly, F.R.S., &c.

On the Distribution of Rain over the British Isles during the Year 1864, as observed at about 900 stations in Great Britain and Ireland. Compiled by G. J. Symons. With Engravings. 75 pp. 8vo. (Stanford.)

For and Against Tobacco; or, Tobacco in its Relations to the Health of Individuals and Communities. By B. W. Richardson, M.A., M.D., Physician to the Royal Infirmary for Diseases of the Chest. (John Churchill & Sons, New Burlington Street.)

Thoughts on the Influence of Ether in the Solar System: its Relations to the Zodiacal Light, Comets, the Seasons, and Periodical Shooting-Stars. By Alexander Wilcocks, M.D. (Trübner & Co.)

On the Relations, Structure, and Function of the Valves of the Vascular System in Vertebrata. By James Bell Pettigrew, M.D. Edin., Assistant in the Museum of the Royal College of Surgeons of England. Plates. 40 pp. 4to.

On the Presumption of Survivorship. By James Bell Pettigrew, M.D. Edin., Assistant in the Museum of the Royal College of Surgeons of England. 35 pp. 8vo.

PERIODICALS, AND PROCEEDINGS OF SCIENTIFIC SOCIETIES.

The Mining and Smelting Magazine. (Simpkins & Co.)

The Geological Magazine. Edited by T. Rupert Jones, F.G.S., and Henry Woodward, F.G.S., &c. (Longmans.)

Revue Universelle des Mines. (Noblet & Baudry, Paris and Liége.)

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation. (Masson, Paris.)

Smithsonian Report, 1863; showing the Operations, Expenditures, and Conditions of the Institution for the year 1862.

Annual Report of the Geological Survey of India, and of the Museum of Geology, Calcutta. Eighth year, 1863-4. With Map. 18 pp. Royal 8vo. (Calcutta.)

Memoirs of the Geological Survey of India. Vol. III. Part 2, Medlicott on the Structure and Relations of the Southern Portion of the Himalayan Ranges between the Rivers Ganges and Ravee. With Plates. 200 pp. Royal 8vo.—Vol. IV. Part 2, King and Foote on the Geological Structure of the Districts of Trichinopoly, Salem, and South Arcot. With Plates. 164 pp. Royal 8vo. Calcutta.

Proceedings of the Royal, Royal Astronomical, Geological, Royal Geographical, and Zoological Societies of London.

With 13 Plates and more than 70 Wood Engravings, Vol. I. (for 1864), 8vo, cloth, 21s.

THE QUARTERLY

JOURNAL OF SCIENCE,

CONTAINING THE FOLLOWING

ORIGINAL ARTICLES.

EDWARD HULL, B.A., F.G.S. The Coal Resources of Great Britain.
Dr. G. C. WALLICH, F.L.S. The Atlantic Deep-Sea Bed and its Denizens.
WM. CROOKES, F.R.S. The Atlantic Cable and its Teachings.
ROBERT MALLET, C.E., F.R.S. The Late Earthquake, and Earthquakes generally.
Dr. J. H. GLADSTONE, F.R.S. Lighthouse Illumination by Magneto-Electricity.
Dr. W. B. CARPENTER, F.R.S. The Conservation of Force Applied to Physiology. Part I. The Relation of Light and Heat to the Vital Forces of Plants. Part II The Relation of Light and Heat to the Vital Forces of Animals.
Professor KING, Galway. The Reputed Fossil Man of Neanderthal.
Dr. SCLATER, M.A., F.R.S. The Mammals of Madagascar.
Sir J. W. F. HERSCHEL, Bart., D.C.L., F.R.S. The Solar Spots.
MARTIN SAMUELSON, C.E. Steam Navigation: its Rise, Progress, and Prospects.
WILLIAM TURNER, M.B., F.R.S.E. The Fossil Skull Controversy: Human Crania allied in Anatomical Characters to the Engis and Neanderthal Skulls.
Dr. AUG. VOELCKER. On Milk, and Dairy Arrangements.
JAMES NASMYTH. The Physical Aspects of the Moon's Surface.
J. SCOTT RUSSELL, C.E., F.R.S. Gun Cotton.
H. M. JENKINS, F.G.S. Brackish Water Fossils of Crete.
T. NUNNELEY, F.R.C.S.E. The History and Uses of the Ophthalmoscope.
CUTHBERT COLLINGWOOD, M.A., M.B. Oxon., F.L.S. Acclimatization.
D. T. ANSTED, F.R.S. Copper Mining in Tuscany.
BALFOUR STEWART, M.A., F.R.S. Radiant Light and Heat.
JAMES SAMUELSON, Editor. The Source of Living Organisms.
Professor TH. LACAZE DUTHIERS, Paris. The Formation of Coal.
WILLIAM FAIRBAIRN, LL.D., F.R.S. The Construction and Mechanical Properties of Submarine Telegraph Cables.
Dr. WILLIAM ODLING, F.R.S. The Proportional Numbers of the Elements.
ROLAND TRIMEN, Cape Town. The Butterflies of Madagascar.

CHRONICLES OF SCIENCE.

Agriculture.
Astronomy.
Botany and Vegetable Physiology.
Chemistry.
Geography.
Geology and Palæontology.
Microscopy.
Mining, Mineralogy, and Metallurgy.
Photography.
Physics: Optics, Light, Heat, Electricity.
Sanitary Science.
Zoology and Animal Physiology.
Recent Scientific Progress in America.
Science: in the Provinces—in Asia.

REVIEWS OF BOOKS.

ORIGINAL NOTES AND CORRESPONDENCE.

REPORT OF THE MEETING AT BATH OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

JOHN CHURCHILL & SONS, NEW BURLINGTON STREET.

XUM

TO ADVERTISERS.

QUARTERLY JOURNAL OF SCIENCE.

SCALE OF CHARGES.

	£	s.	d.
Eighth of a Page, or under . . .	0	6	0
Quarter of a Page	0	11	6
Half a Page	1	1	0
A Page	2	0	0
Bills inserted	2	2	0